"A RANDOMIZED CONTROLLED TRIAL TO EVALUATE AND COMPARE THE VERTICAL MARGINAL FIT OF MONOLITHIC ZIRCONIA CROWNS OBTAINED USING INTRA-ORAL SCANNING VS MONOPHASE IMPRESSION TECHNIQUE- AN IN VIVO STUDY"

Dissertation submitted to

SANTOSH DEEMED TO BE UNIVERSITY, GHAZIABAD, NCR, DELHI

In partial fulfillment of the requirement for the degree of

MASTER OF DENTAL SURGERY

In the Specialty of

PROSTHODONTICS AND CROWN & BRIDGE

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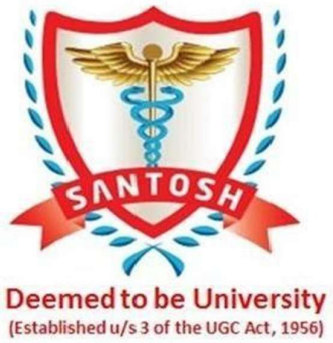

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ANTI PLAGIARISM DECLARATION/UNDERTAKING

I, **Dr. RUSHIKESH KAKNALE,** hereby declare that the present thesis entitled, **"A RANDOMIZED CONTROLLED TRIAL TO EVALUATE AND COMPARE THE VERTICAL MARGINAL FIT OF MONOLITHIC ZIRCONIA CROWNS OBTAINED USING INTRA ORAL SCANNING VS MONOPHASE IMPRESSION TECHNIQUE- AN IN VIVO STUDY"** submitted by me to Santosh Deemed to be University is a bonafide/ original research work. I also hereby declare that the similarity index is less than ten percent and the present research work has not been submitted for the award of any degree/diploma of the same Institution where the work was carried out or to any other Institution.

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I have verified the contents of the thesis, and is less than ten percent.

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ACKNOWLEDGEMENTS

Firstly, I would like to thank the best teacher and guide of all, the almighty. I would never forget God's immense contribution in providing me with a vast amount of mental and physical strength during my roller-coaster of a journey in this project.

Thereafter, it is my proud privilege to acknowledge with a deep sense of gratitude. The invaluable guidance is given to me by my mentor (Prof.) Dr. Rajiv Kumar Gupta, Head Of the Department of Prosthodontics and Crown & Bridge, Santosh Dental College, and Hospitals, was the primary motivation and support source for me while completing my dissertation. His expertise, invaluable guidance, constant encouragement, affectionate attitude, understanding, patience, and healthy criticism have helped me extract the best out of myself and have helped me mainly through this project.

I want to extend my heartfelt gratitude to (Prof.) Dr. Akshay Bhargava, Dean, Santosh Dental College and Hospitals, for permitting me to use the scientific literature and research facilities of the college, and for his selfless contribution of time, calmness, wisdom, along with constant inspiration, and for the valuable suggestions rendered in this study.

I would also like to express my deep sense of gratitude to my co-guide Dr. Bharti Dua (MDS), Department of Prosthodontics, Santosh Dental College and Hospital, for her valuable suggestions and advice throughout.

I would also like to express my deep sense of gratitude to my faculty Dr Manoj Kr. Goyat, Dr. Kavita Gupta and Dr. Cherry Anmol of the Department of Prosthodontics, Santosh Dental College and Hospital, for their valuable suggestions and support.

I am highly obliged to my parents, Mr. Narsing Kaknale and Mrs. Sharda Kaknale. They have been a constant support and are inclined towards shaping my career. I am thankful to them for teaching me all the right things, which matter a lot in life. Their complete faith in me genuinely inspires me to grow in both my professional and personal life. They are a pillar of strength and boost my morale at all times.

I would also like to thank my sister, Mrs. Rutuja Kaknale, for standing by me and making me feel happy even in my low times, and for the immense support and love whenever I needed it.

I extend my thanks to my Co-PGs, Dr. Manisha Yersong, Dr Mahitosh Lakhe, Dr. Trisha Verma & Dr Ambika Verma for their valuable support and ready to lend a helping hand whenever needed. I have never met anyone who is more kind-hearted, caring, and supportive than you. Thank you for being such fantastic colleagues. I sincerely admire my seniors, Dr. Vishwas Uckoo, Dr Shreya, Dr Hunny Khaitan, throughout the journey for their invaluable support, help, love, and care.

Thanking you,

Dr. RUSHIKESH KAKNALE

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LIST OF ABBREVIATIONS

SR. NO.	ABBREVIATIONS	FULL FORM
1.	FDP	Fixed dental prosthesis
2.	CAD/CAM	Computer Aided Design/Computer Aided Manufacturing
3.	DMLS	Direct Metal Laser Sintering
4.	SEM	Scanning Electron Microscope
5.	STL	Stereolithography
6.	MAD/MAM	Manually Aided Design/Manually Aided Manufacturing
7.	CEREC	Chairside Economical Restorations of Esthetic Ceramic
8.	LC	Large chamfer
9.	TC	Tilted chamfer
10.	RS	Round shoulder
11.	SRT	Silicone Replica Technique
12.	TSM	Triple Scan Method
13.	MCT	Micro Computed Tomography
14.	SD	Standard Deviation
15.	ANOVA	Analysis of variance
16.	µM	microns
17.	MLA	Metal laser sintering
18.	P value	Value Probability

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Introduction

INTRODUCTION

Fixed prosthodontics, encompassing dental crowns and fixed partial dentures (FPDs), is a fundamental aspect of restorative dentistry that offers durable and aesthetically pleasing solutions for the replacement of missing teeth. These restorations not only restore form and function but also contribute significantly to the patient's psychological well-being by improving facial aesthetics, phonetics, and self-confidence. With increasing awareness of biocompatibility and aesthetic outcomes among patients, the demand for fixed solutions that mimic natural dentition in function, appearance, and maintenance has grown considerably. [1]

FPDs remain one of the most reliable and widely accepted treatment options for the replacement of missing teeth. They provide a stable, fixed solution that enhances mastication, maintains occlusal stability, and improves both comfort and appearance. By preventing the drifting of adjacent teeth and maintaining arch integrity, FPDs contribute to long-term oral health and functionality. Additionally, they serve as a viable alternative in situations where implant therapy is contraindicated due to anatomical, medical, or financial limitations.[2]

The successful integration of FPDs into restorative treatment planning depends on careful case selection. Indications typically include the presence of healthy abutment teeth with sufficient periodontal support and favourable crown-to-root ratios. However, contraindications such as mobility, periapical pathology, insufficient crown height, or compromised periodontal health must be carefully considered. In patients with parafunctional habits such as bruxism, occlusal management becomes critical to prevent prosthesis failure. Furthermore, when FPDs are planned in the aesthetic zone, factors like gingival biotype and smile line must be meticulously evaluated to ensure pleasing esthetic outcomes.[3]

From a clinical perspective, the longevity of fixed prosthodontic restorations depends on multiple interrelated factors—ranging from the biological condition of abutments to precision

in material selection and technique. Among these, marginal fit stands out as one of the most critical determinants of long-term success. A well-adapted margin minimizes microleakage, reduces cement dissolution, and prevents plaque accumulation, thereby lowering the risk of secondary caries and gingival inflammation. Numerous clinical studies have established a direct relationship between marginal integrity and prosthetic longevity.[4]

Smaller marginal discrepancies result in less cement washout, reduced bacterial infiltration, and minimal gingival irritation—all of which contribute to the improved performance and extended life span of the prosthesis. Therefore, achieving optimal marginal fit is not merely a laboratory concern but a clinical imperative that directly influences both the biological and mechanical success of fixed restorations.[5].

Marginal fit — the precise adaptation of the crown or prosthesis margin to the finish line of the tooth preparation — is crucial not only for preventing microleakage and secondary caries but also for maintaining periodontal health and ensuring the mechanical durability of the restoration. Literature suggests that an ideal marginal discrepancy should not exceed 120 μm. Larger gaps facilitate bacterial colonization, plaque accumulation, and ingress of oral fluids, leading to chronic inflammation, cement dissolution, hypersensitivity, and eventual restoration failure. An ill-fitting margin may also result in increased occlusal stress concentration, microfracture initiation in brittle materials, and compromised aesthetics due to marginal staining. Therefore, minimizing marginal discrepancy is fundamental to the long-term success of any fixed restoration.[6]

The finish line design of the prepared tooth is one of the most critical factors influencing marginal fit. The finish line serves as the reference for crown fabrication, guiding both the technician in crown design and the cementation process. Among various configurations — including shoulder, deep shoulder, feather edge, and chamfer — the chamfer finish line strikes

a balance between ease of preparation, stress distribution, and restorative material thickness. The chamfer finish line is characterized by a smooth, rounded concave slope that facilitates precise impression capture and allows for sufficient material bulk at the margins, especially important for high-strength ceramics like zirconia. In this study, a chamfer finish line is specifically chosen for its well-documented advantages when preparing abutments for monolithic zirconia crowns.[7]

Chamfer margins have been shown to reduce the risk of marginal chipping — a critical concern for brittle ceramic restorations — by avoiding sharp internal angles that act as stress concentrators. Moreover, the smooth transition between prepared and unprepared tooth surfaces allows for superior adaptation of the prosthesis margin, promoting better sealing and load distribution during functional activities. The geometry of the chamfer also facilitates easier seating of the final restoration without undue wedging forces that might distort or damage the crown. Clinically, chamfer finish lines are easier to detect both visually and tactilely, assisting the operator in achieving uniform reduction and avoiding over- or under-preparation.[8]

As material science has evolved, zirconia has become increasingly popular for fabricating all-ceramic restorations. Introduced into dentistry in the late 1990s, yttria-stabilized tetragonal zirconia polycrystals (Y-TZP) exhibit exceptional mechanical strength, fracture toughness, and wear resistance, making them highly suitable for posterior restorations subjected to high masticatory forces. Zirconia's unique transformation toughening mechanism — wherein stress-induced phase transformation from tetragonal to monoclinic phase results in volumetric expansion and crack closure — contributes significantly to its fracture resistance. This property distinguishes zirconia from other dental ceramics, which are inherently brittle and prone to catastrophic failure upon crack initiation.[9]

Over time, successive generations of zirconia have been developed to balance mechanical properties and optical qualities. First-generation zirconia, rich in 3 mol% yttria, prioritized strength but was relatively opaque, limiting its use in esthetically critical regions. Second- and third-generation zirconia incorporated increased yttria content (4–5 mol%) to enhance translucency by stabilizing a greater proportion of the cubic phase, albeit at a slight compromise in strength. These developments have allowed clinicians to use monolithic zirconia crowns in both anterior and posterior regions, combining acceptable esthetics with superior mechanical reliability. The monolithic design eliminates the need for veneering porcelain, thus removing a primary source of prosthesis failure — chipping or delamination of the veneering layer.[10]

Biologically, zirconia exhibits excellent biocompatibility, minimal bacterial adhesion, and favorable soft tissue responses, making it an ideal material for long-term intraoral use. Its low surface energy discourages plaque accumulation, which is particularly beneficial at crown margins where plaque-induced inflammation could otherwise jeopardize both periodontal and restorative outcomes. Furthermore, zirconia's color stability, chemical inertness, and resistance to low-temperature degradation contribute to its desirability as a restorative material. Thus, in the context of FPDs fabricated on chamfer finish lines, monolithic zirconia crowns offer a promising combination of strength, longevity, and biocompatibility.[11]

The accuracy of the final restoration is heavily dependent on the precision of the impression-making procedure. Traditionally, elastomeric materials like addition silicone and polyether have been the gold standard for recording the fine details of prepared teeth. The monophase impression technique simplifies the impression procedure by using a single-viscosity material that flows adequately under pressure but maintains stability once set. Monophase materials are particularly advantageous in clinical situations where moisture control is challenging or where multiple preparations need simultaneous capture. However, conventional impressions are not without limitations. Variables such as tray rigidity, adhesive application, material mixing,

working time, setting time, and impression removal technique can all introduce inaccuracies. Moreover, dimensional changes due to polymerization shrinkage and storage conditions post-impression can further distort the working cast.[12]

The emergence of digital impression technology has offered an alternative that seeks to overcome many inherent limitations of conventional methods. Intraoral scanners (IOS) utilize optical or laser-based systems to acquire a detailed three-dimensional representation of the intraoral structures. Modern IOS devices can capture hundreds of thousands of data points within seconds, stitching them into a virtual model with remarkable precision. The digital workflow offers immediate visualization, allowing clinicians to verify and correct errors on the spot, thus reducing the likelihood of undetected inaccuracies. Moreover, eliminating the need for impression trays and materials significantly improves patient comfort and reduces cross-infection risks.[13]

Nonetheless, the accuracy of digital impressions is influenced by various factors, including scanning strategy, angulation, ambient lighting, operator skill, and patient movement. Scanners can struggle in capturing subgingival margins or in moist environments, potentially compromising the quality of the scan. Additionally, the learning curve associated with mastering intraoral scanning techniques must be acknowledged. Despite these challenges, technological advancements have continually improved scanner resolution, speed, and ease of use, making digital impressions increasingly reliable for a wide range of clinical indications.[14]

Comparative studies evaluating monophase versus digital impression techniques have produced nuanced results. Some in vitro and in vivo investigations have demonstrated that digital impressions provide comparable, if not superior, marginal and internal fit compared to conventional impressions, particularly for single-unit restorations and short-span FPDs. Others have highlighted areas where conventional impressions still excel, especially in capturing

subgingival details or managing extensive edentulous spaces. Consequently, critical evaluation using objective measurement methods remains essential.[15]

The silicone replica technique, used in this study for evaluating vertical marginal fit, offers a non-destructive, reproducible, and clinically applicable means of assessing prosthesis adaptation. This technique involves applying a low-viscosity silicone between the restoration and abutment, sectioning the set material, and measuring the resulting film thickness under magnification. It has been validated by numerous studies as a reliable indicator of marginal and internal fit, correlating well with destructive sectioning methods while preserving the integrity of the restoration for final use.[16]

Achieving excellent marginal fit is essential not just for immediate success but also for the prosthesis's long-term biological and mechanical integrity. Biological consequences of poor marginal adaptation include plaque accumulation, gingival inflammation, periodontal attachment loss, secondary caries, and pulpal pathology. Mechanically, gaps or overhangs can lead to stress concentrations, flexural fatigue, microcrack propagation, and ultimate prosthesis failure. Therefore, marginal fit is not merely a technical parameter but a critical determinant of restoration success and patient satisfaction.[17]

In the context of the present study, careful tooth preparation with a chamfer finish line, selection of monolithic zirconia as the restorative material, and comparison of monophase versus intraoral digital impressions form a scientifically sound basis for evaluating vertical marginal fit. By focusing on vertical discrepancies, which are most directly linked to cement seal integrity and biological outcomes, the study aims to provide clinically relevant insights that can guide prosthodontic practice toward improved patient outcomes.[18]

the field of fixed prosthodontics continues to evolve with advancements in material science, digital technology, and clinical techniques. Yet, fundamental principles such as precise tooth

preparation, meticulous impression making, and achieving excellent marginal fit remain as critical today as they were decades ago. By rigorously comparing conventional and digital workflows in the fabrication of monolithic zirconia crowns on chamfer-prepared abutments, this study seeks to contribute valuable evidence to contemporary prosthodontic literature, helping clinicians make informed, evidence-based choices that prioritize both function and longevity for their patients.[19]

There is considerable evidence regarding the accuracy and efficacy of the digital impression technique, but the literature lacks evidence when it comes to a comparison between the digital and conventional techniques. Therefore, the purpose of this study was to evaluate and compare the marginal Adaptation of monolithic zirconia crowns obtained using by Digital impression vs conventional impression. The null hypothesis was that There Is No Difference In Marginal Adaptation Of Monolithic Zirconia crowns obtained Using Digital Impression And Conventional (Monophase) Impression Techniques.

Aim
&
Objectives

AIM AND OBJECTIVES

AIM:

The Aim of This Study Is to Clinically Evaluate The Marginal Adaptation Of Monolithic Zirconia Crowns As Obtained Using Digital Impression And Conventional (Monophase) Impression.

OBJECTIVES:

1. Evaluation of the Marginal Adaptation of Monolithic Zirconia crown obtained using the Conventional impression by Silicone Replica technique.
2. Evaluation of the Marginal Adaptation of Monolithic Zirconia crowns obtained using Digital impression by Silicone Replica technique.
3. Comparative evaluation of the Marginal Adaptation of Monolithic Zirconia crown Fabricated using Conventional (monophase) impression and Digital impression by silicone Replica method

Research Hypothesis

RESEARCH HYPOTHESIS

RESEARCH HYPOTHESIS

NULL HYPOTHESIS: - There Is No Difference in Marginal Adaptation Of Monolithic Zirconia Crown Obtained Using Digital Impression And Conventional (Monophase) Impression.

ALTERNATE HYPOTHESIS: - There Is a Difference In Marginal Adaptation Of Monolithic Zirconia Crowns Obtained Using Digital Impression And Conventional (Monophase) Impression.

Review Of Literature

REVIEW OF LITERATURE

Hembree JH Jr. et al (1974) The study investigated how moisture impacts polyether impression materials. The authors found that excessive moisture led to dimensional instability and inaccuracies, indicating the need for strict moisture control during impression-making to maintain fidelity in the replication of prepared teeth.

Nayyar A et al. (1979) This comparative study evaluated polyether and polysulfide impression materials, noting differences in their flow, setting times, and dimensional stability. Polyethers were praised for their hydrophilicity and consistent reproduction of detail, while polysulfides offered superior flexibility, providing clinicians with insights into material selection based on clinical scenarios.

Gardner FM. (1982) In this classic literature review, the author examined the ideal characteristics of crown margins. It was concluded that marginal fit plays a crucial role in the longevity of restorations and periodontal health. Gardner emphasized that well-adapted margins reduce plaque retention and cement dissolution, serving as a critical factor in prosthesis success.

Johnson GH et al (1988) This research analyzed the effect of disinfection via immersion on elastomeric impression materials. Findings showed certain disinfectants altered the materials' dimensions slightly, reinforcing the importance of using compatible disinfectants and adhering to manufacturer-recommended protocols to ensure accurate impressions.

Holmes JR et al (1989) This article focused on the methods used to measure marginal fit. It discussed the variability introduced by different measurement techniques and the importance of standardizing protocols to ensure reliable comparisons between studies, which remains relevant for future clinical trials and research designs.

Felton DA et al (1991) The study evaluated how marginal discrepancies in crowns affect periodontal health. Clinical observations revealed that poor marginal adaptation led to increased plaque accumulation and gingival inflammation, reinforcing the notion that biological compatibility is directly tied to prosthetic accuracy.

Wang CJ et al (1992) This classic study explored several variables influencing the success of crown cementation, including cement type, cement space, seating aids, marginal configuration, and seating force. Through experimental testing, the authors concluded that each factor plays a significant role in how well the crown seats onto the prepared tooth. Improper cement space or excessive seating force can lead to compromised marginal integrity, increased microleakage, and long-term failure. The study emphasized the importance of calibrating these parameters during clinical procedures to ensure optimal adaptation and longevity of restorations.

May KB et al (1998) May and colleagues investigated the precision of fit in Procera All Ceram crowns. Using cross-sectional analysis and marginal gap measurement techniques, they found that the CAD/CAM-fabricated ceramic crowns demonstrated excellent adaptation, often within clinically acceptable ranges. The study was among the earlier validations of CAD/CAM accuracy and set a precedent for later technologies.

Craig RG. (2001) In the textbook *Restorative Dental Materials* (11th ed.), Craig provides foundational knowledge about dental materials, including their mechanical properties, behavior under stress, and interaction with clinical variables such as moisture or temperature. This work remains a cornerstone reference in prosthodontics, guiding material selection and handling in restorative dentistry.

Chen SY et al (2004) Chen and associates conducted a study investigating the variables that affect the accuracy of elastomeric impression materials, particularly focusing on

polyvinyl siloxane (PVS) and polyether. Factors such as working and setting time, humidity, temperature, and tray selection were found to influence dimensional stability. The study underscored the need for clinicians to adhere strictly to manufacturers' instructions and environmental guidelines to avoid compromised impressions that could affect final prosthesis fit.

Donovan TE et al (2004) This review article outlines the most relevant impression materials and techniques in contemporary prosthodontics. The authors explored the indications, advantages, and limitations of various elastomeric materials and stressed the role of clinical technique in determining impression accuracy, directly affecting restoration fit.

Balkaya MC et al (2005) Balkaya and co-authors examined how repeated firing cycles during veneering influenced margin distortion in three all-ceramic systems. They observed that additional firings increased marginal discrepancies, especially in layered systems. Their results highlighted the importance of minimizing unnecessary firing cycles and ensuring careful thermal management during ceramic processing to preserve marginal integrity.

Bindl A et al. (2005) This study assessed ceramic CAD/CAM crown copings fabricated on chamfer preparations. The researchers concluded that marginal and internal adaptation was generally excellent, provided that the chamfer finish line was meticulously prepared. The study reinforced the recommendation for conservative and smooth preparation geometries to optimize ceramic coping fit.

Kenyon BJ, et al. (2005) This research compared the dimensional accuracy of seven commonly used die materials, including resin-reinforced gypsum and epoxy resins. Using precision measuring equipment, the authors evaluated linear and volumetric discrepancies

from the master model. They found significant variability among the materials, with some offering superior resistance to expansion or distortion. This study emphasized the importance of selecting high-quality die materials, as inaccuracies at the model stage can propagate through the prosthesis fabrication process, impacting marginal adaptation.

Tsitrou EA et al. (2007) This study focused on evaluating the marginal fit of resin composite crowns fabricated using three different margin designs—shoulder, chamfer, and rounded shoulder—via CAD/CAM. The marginal accuracy was assessed using microscopy. The authors found that chamfer margins produced the best results, suggesting that both design and digital manufacturing processes must be carefully coordinated to ensure optimal fit.

Rubel (2007) provided a detailed review of commonly used impression materials in restorative dentistry, highlighting the advantages and limitations of each type. His analysis emphasized that elastomeric materials such as polyvinyl siloxane and polyether remain the gold standards for accuracy and tear resistance. The review also mentioned that advancements in material science continue to refine their handling properties and detail reproduction, which are crucial for marginal integrity in indirect restorations.

Kunii J et al. (2007) Kunii and co-researchers examined how the sintering process affects the dimensional accuracy and fit of zirconia frameworks fabricated by CAD/CAM. Sintering involves high-temperature processing that causes shrinkage of zirconia, and the study found that these changes can negatively impact both marginal and internal fit if not properly compensated for in the CAD design. Their work highlighted the importance of precise calibration of sintering parameters and the need for design software to account for post-sintering distortions to achieve optimal restoration fit.

Lee KB et al. (2008) In this in vitro study, the authors compared the marginal and internal fit of all-ceramic crowns fabricated using two different CAD/CAM systems. The findings highlighted notable variations between the two systems, emphasizing that the choice of CAD/CAM system can significantly affect prosthesis accuracy. The study suggested that one system consistently produced superior fits, likely due to better scanning and milling resolution, underscoring the importance of understanding system-specific capabilities in clinical settings.

Persson et al. (2008) analyzed digitized dental stone replicas using CAD/CAM technology to evaluate the precision of model reproduction. Using computer-assisted measurements, they demonstrated that digital methods could reliably detect and quantify discrepancies in fit. Their findings confirm that CAD/CAM tools are not only beneficial for fabrication but also useful in validating the dimensional accuracy of both conventional and digital workflows.

Caputi and Varvara (2008) evaluated the dimensional accuracy of casts produced through three different impression techniques: monophase, one-step putty/light-body, and a two-step putty/light-body approach. Their results revealed that the two-step technique offered the highest level of detail reproduction and dimensional stability. This finding is crucial in clinical prosthodontics, reaffirming that proper layering and timing in conventional impressions can rival modern digital methods in delivering precise results.

Rahme HY et al (2008) Rahme and colleagues conducted an in vitro study to evaluate the accuracy and reliability of the "replica technique" for assessing the fit of Procera all-ceramic crowns. The method involved filling the intaglio surface of a crown with light-body silicone and placing it over the prepared tooth or die. Once set, it was stabilized with a putty material and then sectioned for microscopic analysis. The study found that this

technique offers a non-destructive, simple, and reproducible method to evaluate both the marginal and internal fit of crowns. It avoids the need for crown removal or destruction and can be effectively used in both research and clinical settings to monitor prosthetic accuracy.

Techkouhie A et al. (2010) presented a comprehensive review on various impression materials commonly used in fixed prosthodontics, focusing on their composition, properties, advantages, disadvantages, and clinical applications. The study provided comparative insights into traditional and modern materials, including polyethers, polyvinyl siloxanes (PVS), polysulfides, and condensation silicones. Rubel emphasized how specific material characteristics—such as dimensional stability, hydrophilicity, elasticity, and working time—can significantly influence the clinical outcome and decision-making process. By synthesizing data from Medline, textbooks, manufacturer information, and internet resources, the review offered clinicians a practical guide to selecting the most appropriate impression material for fixed restorations based on individual clinical scenarios.

Abduo J et al. (2010) This systematic review critically analyzed various studies on the marginal and internal fit of zirconia fixed partial dentures (FPDs). The review concluded that zirconia prostheses generally exhibited good fit but were influenced by factors like CAD/CAM system type, sintering shrinkage, and framework complexity. The paper provided strong evidence supporting zirconia as a viable material for FPDs, while also stressing the importance of technical optimization for each step in the digital workflow.

Sang J. Lee et al (2010) In this crossover clinical trial, the researchers evaluated the clinical performance of single implant-supported restorations fabricated using digital scanning and CAD-CAM techniques compared to conventional impressions and gypsum casts. Thirty participants received both types of impressions, and two crowns were fabricated per

implant. Time efficiency, accuracy, and patient preferences were assessed. Results showed that digital scanning required significantly less time overall (11.28 minutes vs. 14.16 minutes; $P<.001$), though it had a longer remake time. Adjustment times were statistically similar. Final crowns delivered were nearly evenly split between the two methods (53.3% digital vs. 46.7% conventional), and a strong majority of participants (89%) preferred the digital technique. The study concluded that digital scanning was more time-efficient and equally accurate, with higher patient satisfaction than conventional impressions.

Syrek A et al. (2010) Syrek and co-authors performed a clinical evaluation of full-contour all-ceramic crowns fabricated from digital intraoral impressions, employing the active wavefront sampling principle. The crowns were made from lithium disilicate ceramics and were compared to those created from conventional impressions. Their findings demonstrated that restorations produced from digital scans had significantly better marginal fit and required fewer chairside adjustments. This supported the growing acceptance of digital impression technologies as not only a more comfortable option for patients but also as a precise method to improve clinical outcomes.

Renne et al. (2012) conducted a study to evaluate how common preparation errors affect the marginal fit of crowns fabricated using CAD/CAM systems. The researchers introduced clinically relevant errors such as over-tapering, short axial walls, unsupported enamel, and indistinct finish lines in prepared teeth. Their findings indicated that these preparation faults significantly compromised the marginal integrity of the restorations, despite the use of advanced digital technology. This study underscores the essential role of precise clinical execution in achieving optimal results from CAD/CAM workflows.

B. Trifkovic1 et al. (2012) This study compared the marginal gap measurements of ceramic crowns fabricated using a Cerec CAD/CAM system, utilizing both the replica technique

and scanning electron microscopy (SEM). Three groups were assessed, with crowns produced via two extraoral and one intraoral optical scanning systems from the Cerec series. The findings revealed a statistically significant difference in marginal gap values among the scanning systems when evaluated using the replica method. Additionally, marginal gap measurements obtained via the replica technique were consistently lower than those measured by SEM, highlighting how the choice of measurement method can influence the perceived accuracy of crown fit

Souza et al. (2012) explored the relationship between margin design and the marginal/internal discrepancies of ceramic crowns produced via CAD/CAM. They compared different margin configurations—shoulder, chamfer, and rounded shoulder—and discovered that the shoulder design produced the most favorable internal and marginal fit. Their work highlights the nuanced impact of design choices on crown adaptation, especially in relation to the chosen ceramic material and processing parameters[3].

Flügge TV et al. (2013) Flügge and colleagues compared the precision of intraoral digital impressions using the iTero scanner with extraoral digitization via a laboratory model scanner. The study analyzed multiple 3D datasets using advanced software for surface comparison. Findings indicated that intraoral digital scanning was highly accurate and, in many cases, surpassed extraoral methods in precision. The authors advocated for the clinical adoption of intraoral scanners to streamline workflows and enhance prosthetic outcomes.

Colpani JT et al. (2013) The authors evaluated both the marginal and internal fit of ceramic crown copings produced via CAD/CAM. The results showed that while all systems evaluated were within clinically acceptable limits, certain systems yielded more consistent

fits. This emphasized the importance of precision during scanning and coping design to minimize internal gaps, which could affect cement thickness and, consequently, longevity.

Yildiz C et al. (2013) This in vitro research examined the marginal adaptation and fracture resistance of CAD/CAM-manufactured crown restorations. Different materials and processing parameters were assessed. The results demonstrated a direct relationship between marginal adaptation and overall mechanical performance—crowns with better marginal integrity showed improved fracture resistance. The study reinforced the notion that precise marginal fit is not only critical for biological compatibility but also for mechanical durability.

Ali AAA, Sabea NR. (2013) Ali and Sabea conducted a comparative study analyzing the marginal adaptation, internal fitness, and microleakage of Zolid, Zirconia, and Empress 2 all-ceramic crowns. Using standardized tooth preparations and replica techniques, they concluded that Zolid crowns provided superior marginal accuracy, while Empress 2 displayed higher susceptibility to microleakage. These results underscored the need to carefully consider both material properties and clinical indications when choosing an all-ceramic system.

Brawek PK et al. (2013) This clinical study compared two digital workflows for fabricating single crowns, assessing their overall accuracy. Results indicated that both systems produced acceptable outcomes, but variations in precision were attributed to scanner resolution and software calibration, highlighting the need for system-specific understanding in digital dentistry.

Contrepois M et al. (2013) A systematic review conducted by the authors compiled data on the marginal adaptation of ceramic crowns. The findings emphasized the influence of material choice, manufacturing technique, and cementation protocol. It provided evidence

that both CAD/CAM and conventional methods could produce acceptable margins, depending on operator expertise and system accuracy.

D. Wismeijer et al. (2013) This clinical study compared patient preferences and the time required for analog impressions versus intraoral (IO) scans in restoring implants in the non-aesthetic zone. Thirty patients with 41 implants underwent both impression techniques, followed by a questionnaire assessing comfort and experience. Results showed a significant preference for IO scanning, mainly due to better comfort during preparatory steps and the absence of unpleasant taste. Although the IO scan took slightly more time and was perceived as longer by patients, it was still favored overall for its improved patient experience.

Wismeijer D et al. (2014) In this clinical preference study, patients compared polyether analog impressions with digital intraoral scans for implant restorations. The digital method was generally preferred for comfort and speed, without compromising accuracy. These findings supported the patient-centered move toward digital workflows in implant and fixed prosthodontics

Euan R et al. (2014) This in vitro study assessed the marginal adaptation of zirconia copings influenced by the type of CAD/CAM system and finish line design. Findings demonstrated that both variables significantly affected fit, underscoring the clinical importance of finish line configuration and proper system calibration in achieving optimal crown adaptation.

Sebastian B.M. Patzelt et al (2014) aimed to evaluate the time efficiency of intraoral scanners in computer-aided impression making (CAIM) compared to conventional impression techniques. The study involved three different intraoral scanners and examined three scenarios: digitizing a single abutment (scenario 1), a short-span fixed dental

prosthesis (scenario 2), and a full-arch prosthesis preparation (scenario 3). The procedure durations for digital impressions were measured and compared with the time required for conventional impressions using various materials. The results indicated that the mean total time for making digital impressions ranged from 5 minutes 57 seconds for scenario 1 to 20 minutes 55 seconds for scenario 3. Statistically significant differences in procedure durations were found between all scanners for the various scenarios, except for specific pairs of scanners under certain conditions. In contrast, conventional impressions took much longer, with procedure times ranging from 18 minutes 15 seconds to 30 minutes 25 seconds, depending on the scenario. The study concluded that CAIM using intraoral scanners was significantly faster than conventional impressions in all tested scenarios, suggesting that digital impressions can enhance time efficiency and streamline the workflow in clinical practice. This finding demonstrates the potential of intraoral scanners to improve efficiency in dental procedures, contributing to faster treatment delivery.

Jonathan Ng et al. (2014) This study aimed to compare the marginal fit of crowns fabricated using digital and conventional methods. The maxillary right second premolar was prepared for a ceramic crown on a typodont, which was digitized with a laboratory scanner to create a master model. Digital impressions were recorded and sent to a dental laboratory, where crowns were designed and fabricated using computer-aided design and computer-aided manufacturing (CAD/CAM) technology. In contrast, conventional impressions were made for the fabrication of crowns using a laboratory method. Marginal gap measurements were taken at eight specific sites on each crown, and the vertical component of the marginal gap was evaluated to assess the fit. The results showed that the mean vertical gap for digitally fabricated crowns was significantly smaller (48 ± 25 μm) compared to the conventionally fabricated crowns (74 ± 47 μm), indicating better marginal fit for the digital method. The study concluded that crowns fabricated with digital

impressions and CAD/CAM technology provided superior marginal fit compared to those made using conventional methods

Euán et al. (2014) investigated the effect of finish line design and CAD/CAM system selection on the marginal fit of zirconia copings. The study compared different CAD/CAM systems and finish lines—chamfer and shoulder—influencing the adaptation of zirconium dioxide restorations. Results showed that the type of finish line and the digital system used both had a significant impact on marginal fit, with chamfer designs providing superior results. This research emphasizes the importance of tailoring the preparation and system selection to maximize prosthetic accuracy.

Anunmana C et al. (2014) This comparative study assessed the gap dimensions between single zirconia crowns and three-unit fixed partial dentures (FPDs). Using a silicone replica technique and optical microscopy, the researchers found that multi-unit frameworks demonstrated larger and more inconsistent gaps, especially at the connector areas. These discrepancies were attributed to the more complex geometries and increased technical challenges associated with fabricating multi-unit prostheses. The authors suggested that additional attention must be paid to digital workflow accuracy and sintering shrinkage when dealing with bridges.

Konstantinos M. et al. (2014) This systematic review compared the marginal and internal fit of fixed dental restorations fabricated using digital versus conventional impression techniques. The review included data from Medline, Cochrane, EMBASE, and hand-searched sources. The findings indicated that restorations made from digital impressions had significantly smaller marginal misfit compared to those made using conventional methods ($P<.05$). Digital dies yielded the most accurate fit, while stone die casts showed the largest discrepancies. Stereolithographic (SLA) or polyurethane dies provided

intermediate results. The type of restoration, impression material, or fabrication technique did not significantly affect the misfit, whereas die and restoration materials did (P<.05). Despite relying mainly on in vitro studies, the review concluded that digital impressions offer superior marginal and internal fit for fixed dental restorations.

Emir Yuzbasioglu et al (2014) This clinical study aimed to compare patient comfort and preference between digital and conventional impression techniques. Twenty-four participants with no prior experience underwent both conventional polyether impressions and digital scans using the CEREC Omnicam system, two weeks apart. A standardized questionnaire and the State-Trait Anxiety Scale assessed participants' perceptions and stress levels. Processing times for each impression method were also recorded. The results showed that digital impressions were significantly faster and more comfortable than conventional methods ($p < 0.05$). Most patients preferred the digital technique, highlighting its superior efficiency and user-friendliness.

Raúl Euán et al. (2014) This study aimed to evaluate the marginal adaptation of zirconia copings fabricated using two CAD/CAM systems: the Lava All-Ceramic System (based on conventional impressions) and the Lava Chairside Oral Scanner (digital impressions), while also comparing two finish line designs—90° round shoulder and 45° chamfer. Forty extracted human molars were prepared and divided into four groups. Marginal gaps were measured at five points per side under 40× magnification. Results showed significantly smaller marginal gaps in restorations made with the digital workflow (Lava Chairside Oral Scanner) compared to the conventional method, regardless of finish line design. Additionally, among restorations fabricated via the conventional method, round shoulder finish lines demonstrated better marginal adaptation than chamfer lines. All values, however, fell within clinically acceptable limits

Esilva JS et al. (2014) In this clinical and in vitro investigation, the authors compared four-unit zirconia prostheses fabricated from digital impressions with those from conventional polyvinyl siloxane impressions. The study found that digital impressions resulted in more consistent and accurate marginal and internal fit. In contrast, conventional impressions showed more variability, especially in long-span restorations. The findings strongly support the use of digital workflows for multi-unit prostheses due to their efficiency, reproducibility, and improved fit outcomes.

Abdel-Azim T et al. (2015) The study evaluated the marginal fit of lithium disilicate crowns fabricated via CAD/CAM using traditional impressions and two intraoral digital scanners. Results revealed that digital scanners performed comparably or better than conventional methods, suggesting that digital impression systems can be reliably integrated into prosthodontic workflows with predictable outcomes.

Pradíes G et al. (2015) This clinical study aimed to compare the fit of all-ceramic crowns obtained via two different impression techniques: conventional silicone impressions and digital intraoral scanning using wavefront sampling technology. The authors found that crowns fabricated from digital impressions exhibited significantly improved marginal and internal fit. Additionally, digital impressions were more time-efficient and reduced potential distortions often associated with traditional materials. This highlighted the growing clinical reliability of digital workflows for producing precision prosthetics.

Tsirogiannis et al. (2016) conducted a systematic review and meta-analysis comparing the marginal fit of ceramic crowns fabricated using digital versus conventional impression methods. The study found that restorations made from digital impressions often showed equal or improved marginal fit compared to those made from traditional techniques. This

supports the growing preference for digital impressions in clinical practice, especially given their potential for reducing errors related to material handling and disinfection.

Peddroche et al. (2016) evaluated the internal and marginal fit of zirconia copings fabricated through various digital scanning methods. Their findings demonstrated that the scanner used significantly affects the adaptation of the final restoration. Some scanners were more adept at capturing marginal contours and detail, leading to superior fits. This study reinforces the importance of equipment quality and calibration when integrating digital technology into restorative workflows.

Özkurt-Kayahan (2016) reviewed the available literature on monolithic zirconia, discussing its advantages over layered zirconia and metal-ceramic restorations. The review emphasized its strength, durability, biocompatibility, and simplified workflow. Notably, the study highlighted that monolithic zirconia offers excellent marginal fit, largely due to the absence of veneering processes and the controlled sintering protocols used in CAD/CAM fabrication.

Al-Adel SK, Majeed MA. (2016) This in vitro study evaluated the marginal and internal fitness of full-contour CAD/CAM crowns made from various materials, including zirconia, lithium disilicate, zirconia-reinforced lithium silicate, and hybrid ceramics. The silicone replica technique was used to assess discrepancies. The study concluded that zirconia and lithium disilicate offered the most accurate fits, while hybrid ceramics showed more variation. Material choice, therefore, plays a significant role in final prosthesis quality.

Sarah Amin et al (2016) This in vitro study evaluated the accuracy of full-arch implant impressions using two intraoral scanners (CEREC Omnicam and 3M True Definition) compared to conventional splinted open-tray impressions in an edentulous mandibular model with five implants. Three implants were parallel while the terminal ones were angled

at 10° and 15°. Ten impressions were taken per group, and 3D deviations from the master cast were assessed by superimposing STL files. Results showed significantly higher accuracy for digital impressions, especially with the True Definition scanner (mean deviation: 19.32 μm), followed by the Omnicam (46.41 μm), and the least accuracy with conventional impressions (167.93 μm). The differences were statistically significant ($P < 0.001$). The study concluded that digital full-arch implant impressions, particularly those taken with the True Definition scanner, are more accurate than conventional splinted open-tray impressions.

Saraswathi et al. (2016) compared the marginal vertical discrepancies of full-contour zirconia crowns, layered zirconia crowns, and conventional metal-ceramic crowns in an in vitro setting. Their results showed that monolithic zirconia crowns exhibited the least marginal gap, followed by layered zirconia and then metal-ceramic crowns. The findings support the clinical use of monolithic zirconia in cases where marginal accuracy and mechanical strength are essential.

Matthias Rödiger et al (2016) A clinical study compared the internal and marginal fit of CAD/CAM-fabricated zirconia single crowns made using conventional polyvinyl siloxane (PVS) impressions and digital impressions with the TRIOS intraoral scanner. The study found that both techniques resulted in crowns with internal and marginal gaps within clinically acceptable ranges. However, digital impressions showed significantly better internal fit in certain areas, such as the chamfer and occlusal regions. No significant differences were found in marginal fit between the two techniques. Overall, both conventional and digital impression methods provided high-precision results, with digital impressions offering advantages in specific internal areas, while both methods produced restorations with clinically acceptable marginal adaptation.

De Paula Silveira AC et al(2017) This study compared the marginal and internal adaptation of crowns fabricated from composite resin and ceramic materials using two different intraoral scanners. The researchers utilized CAD/CAM workflows and evaluated fit using silicone replica techniques and micro-CT scanning. Their findings indicated that the type of scanner, the scanning protocol, and the material selected had a significant effect on the final prosthetic fit. Ceramic crowns showed better consistency in adaptation compared to composite resin, and certain scanners outperformed others in capturing precise digital impressions, highlighting the need for careful technology selection.

Kocaagaoglu H et al (2017) In this in vitro study, the researchers evaluated how different digital impression systems and CAD/CAM production protocols affected the fit of zirconia copings. It was revealed that both the scanning method and manufacturing sequence significantly influenced marginal discrepancies. The study emphasized that even within digital workflows, protocol variations can cause clinically relevant differences in adaptation. Hence, standardizing digital processes is crucial for ensuring consistent quality.

Nawapat Sakornwimon et al (2017) This clinical study aimed to compare the marginal fit of monolithic zirconia crowns fabricated using digital impressions and conventional polyvinyl siloxane (PVS) impressions, as well as to assess patient preferences for each impression technique. Sixteen participants who required single molar crowns were included. Digital impressions were taken using an intraoral scanner, while conventional impressions were made using PVS. Participants completed a questionnaire evaluating various aspects of the impression process, such as time, taste, gag reflex, and overall comfort, with digital impressions receiving significantly higher satisfaction scores in most categories. The marginal fit of the crowns from both techniques was assessed using silicone replicas and no significant differences were found between the two groups in terms of marginal discrepancies. The study concluded that digital impressions provided similar

clinical outcomes to PVS impressions for the fabrication of zirconia crowns, with the added benefit of higher patient satisfaction.

ZAINAB T. AL-ATYAA et al (2018) This in vitro study evaluated and compared the marginal and internal fit of monolithic CAD/CAM zirconia crowns fabricated using four conventional impression techniques and intraoral digital impressions. A maxillary first molar was prepared on a dentoform, and impressions were made using vinyl polysiloxane via two-step putty/wash (with and without spacer), one-step single viscosity, and one-step dual viscosity techniques. Digital impressions were also taken using an intraoral scanner. A total of 40 crowns were fabricated, and the silicone replica technique was used to assess fit at 21 specific points per specimen. Results indicated that digital impressions produced significantly better marginal and internal fit than all conventional techniques. Among conventional methods, the two-step putty/wash technique without spacer showed the best fit, while the one-step dual viscosity technique showed the least accuracy. The study concluded that digital impressions are preferable when available; otherwise, the two-step putty/wash method is the most accurate among conventional approaches.

Inês Margarida Carrilho Baltazar Vaz et al (2020) aimed to compare the marginal fit of zirconia copings fabricated using conventional polyvinyl siloxane (PVS) impressions and two digital scanning techniques (TRIOS 3 and CS 3600). The study was conducted on a typodont mandibular left second premolar, with 10 impressions taken for each group: the PVS group, the TRIOS 3 group (intraoral scanner), and the CS 3600 group (intraoral scanner). The copings were fabricated using CAD-CAM technology, and marginal discrepancies were measured at four locations per specimen using a stereo microscope. The results showed that the TRIOS 3 group exhibited the lowest marginal discrepancy (34 ± 49 μm), followed by the CS 3600 group (93 ± 69 μm), and the PVS group (106 ± 87 μm). Statistically significant differences were found between the PVS and TRIOS 3 groups, as

well as between the CS 3600 and TRIOS 3 groups. The findings suggest that digital scanning with the TRIOS 3 scanner resulted in better marginal fit than both the CS 3600 and conventional PVS impressions. This study highlights the advantages of digital impressions, specifically the TRIOS 3 system, in achieving a more precise marginal fit for zirconia copings.

Irem Gokce Uluc (2021) This in vitro study aimed to compare the marginal and internal fit of 5-unit monolithic zirconia fixed dental prostheses (FDPs) fabricated using CAD/CAM workflows based on direct (intraoral) and indirect (extraoral) digitalization methods. A maxillary typodont model with three prepared abutments was used to fabricate FDPs across six groups involving two intraoral scanners (3Shape Trios 3 and Cerec Omnicam) and two laboratory scanners for scanning impressions and stone casts. A total of 60 zirconia FDPs were milled (10 per group). The results demonstrated no statistically significant differences in marginal or axial gap values among the groups, with mean marginal gaps ranging from 78.2 µm to 82.6 µm and axial gaps from 77.7 µm to 84.5 µm. The study concluded that both direct and indirect digital workflows provide clinically acceptable and comparable marginal and internal fits for zirconia FDPs.

Maundu CN et al (2023) conducted a comparative in vitro study to evaluate the marginal fit of zirconia single crowns and three-unit fixed dental prostheses (FDPs) fabricated using digital versus conventional impression techniques. Using a typodont model, impressions were recorded with four intraoral scanners (Dental Wings, Carestream CS 3600, Medit i700, and i500) and polyether monophase material for conventional impressions. The results revealed that while all methods produced restorations within clinically acceptable marginal gaps (≤150 µm), significant differences were observed between techniques. Notably, polyether impressions for single crowns and the Carestream scanner for FDPs

yielded the best marginal fit, highlighting the potential of both conventional and certain digital methods for high-precision prosthesis fabrication

Mohammad Hassan Kalantari1 et al (2023) This in-vivo study aimed to evaluate the marginal fit of anterior three-unit monolithic zirconia fixed partial dentures (FPDs) fabricated using conventional and scannable polyvinyl siloxane (PVS) impression materials. Ten patients were selected for the replacement of lateral teeth with three-unit zirconia bridges. Each patient had two impressions taken: one with scannable polyvinyl siloxane using a two-step putty-wash technique and another with conventional putty-wash PVS. The marginal discrepancy was measured through replicas, which were cut in both buccolingual and mesiodistal directions. Statistical analysis using an independent t-test revealed no significant differences in the marginal discrepancies between the two methods ($P > 0.05$) for both central and canine abutments.

Materials & Methodology

MATERIALS AND METHODOLOGY

The study was conducted in the Department of Prosthodontics, Santosh Dental College and Hospital, to compare and evaluate the marginal adaptation of monolithic zirconia crowns fabricated by digital impression and conventional impression.

SOURCE OF DATA

- Samples were fabricated in the Department of Prosthodontics, Crown & Bridge, and Implantology, Santosh dental college and hospital, Ghaziabad.
- Fabrication of crown was carried out at Capital dental Lab Ghaziabad.
- Testing was done in the Bansal testing lab Ghaziabad.
- The ethical clearance certificate was obtained from the Institutional Ethics Committee, Santosh Deemed to be university.

MATERIALS AND ARMAMENTARIUM

1. High-speed handpiece (Tornado 401-B2 UNICORN DENTMART, made by BEING).
2. Diamond points for preparation. (SHOFU DENTAL ASIA-PACIFIC PTE. LTD)
3. Irreversible hydrocolloid (Alginate, Prime Chrome)
4. Stock trays.
5. Plaster of paris.
6. Autopolymerising acrylic resin (DPI, India)

7. Digital scanner (shining 3D)
8. Addition silicone- Light body cartridge (Prime Ad sil Acura light body)
9. Separating media
10. Bard-Parker handle #3- Straight, Curved (GDC Dental
11. Modelling wax.
12. Dental stone (kalabhai)
13. Zirconia blanks (cercon dentsply sirona)

EQUIPMENTS

- Intra-oral Scanner (Shining 3D Tech. Co., Ltd., Hangzhou, China)
- Pentamix (Pentamix 3 Automatic Mixing Unit (3M ESPE, St. Paul, MN, USA)
- Lab scanner (AutoScan-DS-EX Pro, Shining 3D Tech. Co., Ltd., Hangzhou, China)
- CAD/CAM milling machine (ARUM 5x-300D, Unicorn Dentmart Ltd., New Delhi)
- Stereomicroscope with image analyser (Leica S9i, Wetzlar, Germany)

METHODOLOGY

A. STUDY DESIGN

The present in vivo study is carrying out the vertical marginal fit of monolithic zirconia crown fabricated using intra oral digital scanner and monophase impression.

B. SAMPLE SIZE DETERMINATION

Purpose of the study, selected 20 patients with all the preferred parameters was divided them into two groups of 20 crown of each.

GROUP A- Monolithic Zirconia crowns obtained using conventional (Monophase) impression technique.

GROUP B- Monolithic Zirconia crowns obtained using Digital impression.

GROUPING OF SAMPLES

GROUP – A (n=20)	GROUP – B (n=20)
Monolithic Zirconia crowns obtained using the Conventional (Monophase) impression	Monolithic Zirconia crowns obtained using Digital impression. .

Table 1- Grouping of samples

C. CRITERIA FOR CASE SELECTION

INCLUSION CRITERIA	EXCLUSION CRITERIA
• RCT-treated mandibular molar teeth • Older than 18 years of age • Acceptable oral hygiene.	• Proximal & Cervical Caries • Tooth mobility • Tooth requiring periodontal surgery before crown preparation

	• Parafunctional habit

Table:2- Study inclusion and exclusion criteria

This study were include 20 patients with treatment plans for single molar crowns. Patients had to be of more than 18-year age and in need of Mandibular 1st molar crown. Inclusion criteria was a tooth free from clinical symptoms with a sufficient endodontic treatment Furthermore, a visible finishing line not more than 1 mm below the gingival margin and an adequate level of oral hygiene expressed by the absence of bleeding on probing and a periodontal pocket probing was require restorations in each patient per abutment were manufactured via conventional (monophase) impression and via digital impression. All patients received a fitting of crown with the assessment of marginal Adaptation using a replica technique. Thus, 20 specimens per group were evaluated. After the evaluation of clinical Adaptation, the framework that offered the best accuracy crown inserted.

PROCEDURE

D. DIAGNOSIS AND CONSENT FORM

Total 20 patient diagnosis and treatment plan selected and inform consent had been taken. Diagnostic impression made followed spacer of 4 mm using modelling wax used. fabrication of custom tray done using autopolymerising acrylic resin done.

E. TOOTH PREPARATION-

The preparation was performed with the objective of getting a chamfer finish line with a circumferential reduction of 1.0 mm and an occlusal reduction of 1.5 mm.

F. DIGITAL IMPRESSION

Intraoral scan Prior to the conventional impression taking, the digital intraoral scan was performed. The scanner was calibrated before scanning each patient, and scanning was performed according to the manufacturer's instructions to capture each quadrant separately. The quadrant with the prepared tooth was scanned first, followed by a quadrant scan of the opposing teeth. The interocclusal registration was performed by a buccal scan with teeth in maximal intercuspation. The resulting digital data set was directly transferred to a CAD software digital design (CAD) of the zirconia crown. According to the manufacturers' information, the models were fabricated.

G. CONVENTIONAL IMPRESSION-

For conventional impressions, a polyether material monophase was used according to the manufacturer's instructions. To enhance the precision of impressions, customised trays based on diagnostic casts were utilised. The antagonist arch impression was taken using an alginate material. The occlusal relationship was recorded in maximal intercuspation using a Modelling wax material. The impressions were disinfected before forwarding them to the dental technician.

H. FABRICATION OF CROWNS

All crowns for both groups (DI and CI) were designed by the same experienced dental master technician using the same software. All restorations were designed and manufactured using the same settings and following the manufacturer's recommendations.

I. CLINICAL RECORDING OF VERTICAL MARGINAL FIT

To assess the clinical accuracy of the crown regarding marginal, the Zirconia crown was coated with a yellow-coloured low-viscosity silicone before seating it on the respective abutment with maximum finger pressure for 10 s. After 4 min, the crown carefully removes, and to stabilise the adherent blue thin silicone film, the crowns was filled with a more rigid blue-coloured silicone to obtain Effective contrast was achieved to clearly distinguish between different material layers. Then, the silicone replica was carefully removed from crown for further processing.

Replica specimen preparation addition to the undercoating of the yellow silicone layer representing the marginal gap with the yellow silicone, a custom-made box was used to cover the replica specimens with a blue-coloured silicone, thus replacing the framework. This box was design to ensure that the position of all specimens was exactly centralized in the encasing blue silicone layer, with all specimens having the same mesio-distal and bucco-lingual orientation. This allowed for sectioning into four pieces (respectively the measurement locations) of each specimen in the mesio-distal and Bucco-oral direction in a reproducible and comparable manner. Sectioning was carried out with BP blades no 15 that was used for only one cut each to avoid wearing effects.

J. MEASURING THE MARGINAL GAP

Measurement of the marginal fit of the four sections of each specimen wasuse to measuring the internal gaps. Two sides of each section (mesio-distal and bucco-lingual) was evaluated for points for marginal gap (mg = marginal gap), and the replica films thickness was measured on a digital microscope. Findings were recorded, and data were statistically analysed.

Fig:1- Intraoral sacnner

Fig:2- Pentamix

Fig:3-Zirconia block(cercon ht)

Fig:4-Model scanner
(shining 3D)

Fig:6-CAD/CAM milling machine (ARUM 5x-300D)

Fig:5-Compact zirconia
sintering furnace
e.ON sinter base

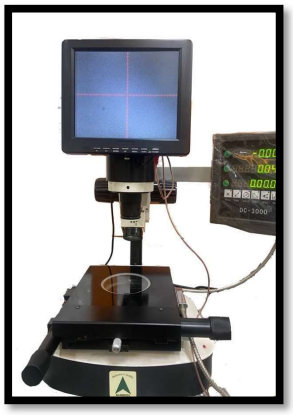


Fig:7-Stereomicroscope with image analyser

Fig:8 -Irreversible Hydrocolloid Impression

Fig:9 -Dental stone

Fig:10- Die stone

Fig:11- Addition silicone light body (yellow colour)

Fig:12- Addition silicone light body (blue colour)

Fig:13 – Digital impression

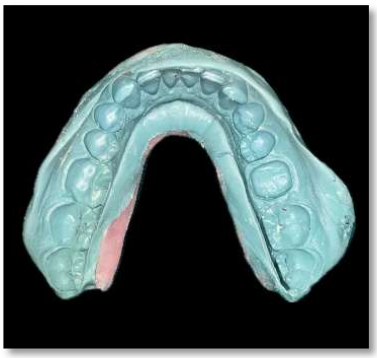


Fig:14 – Conventional (monophase) impression

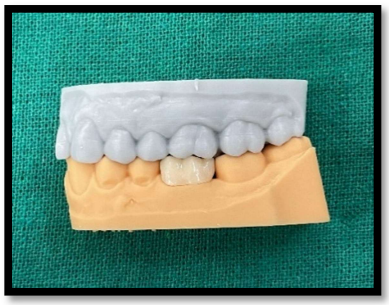


Fig:15– Crown fabricated by Digital Impression

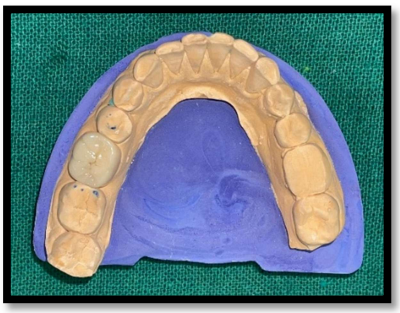


Fig:16- Crown fabricated by Conventional impression

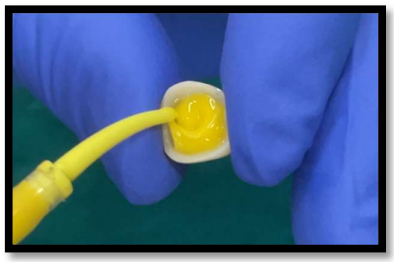


Fig:17 - 1st Pour of light body for cement Space (yellow colour)

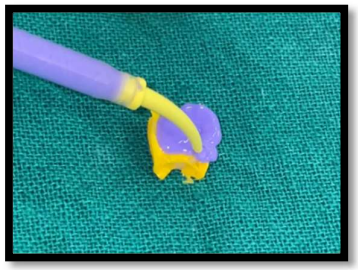


Fig:18-2ND Pour of light body for support cement space(Blue colour)

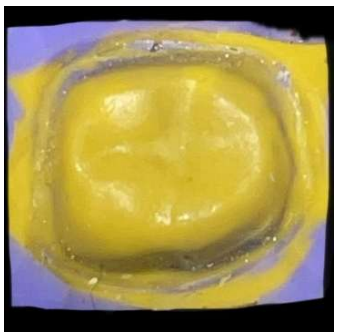


Fig:19- Model after 2nd pour

Fig:20- labeling before section of model

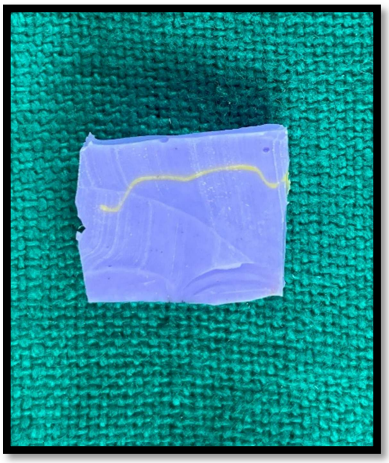


Fig:21-Mold after section into 2 parts

Fig:22-final mold

Fig:23-Scanning under microscope at buccal region

Fig:24-Scanning under microscope at ligual region

Fig:25-Scanning under microscope at mesial mesial region

Fig:26- Scanning under microscope at distal region

Representative case

REPRESENTATIVE CASE

A 38-year-old male presented at the Department of Prosthodontics with complaints of Root canal-treated teeth in the lower left posterior jaw region, seeking replacement options. The patient had no significant medical or dental history. Intraoral examination revealed prosthesis w.r.t. 46 treatment, and radiographic examination revealed RCT treatment w.r.t. 46.

The patient met the inclusion criteria and was selected as a case study sample. During the diagnostic phase, intraoral maximum intercuspation and arch photographs were recorded, and diagnostic impressions were taken after explaining the study protocol and obtaining consent.

Fig:27 – Intraoral pictures with front and lateral view

Fig:28- Intraoral picture with occlusal

Fig:29- Digital impression

Fig:30-Convetional (monophase) impression.

Fig:31-Digital Crown

Fig:32 - conventional crown

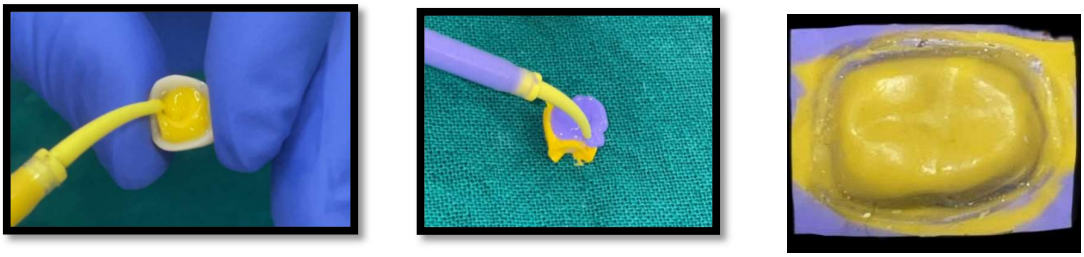


Fig:33 – Fabrication of mold

Fig:34- Marginal Adaptation at Buccal(112) and lingual(128) region of Digital impression.

Fig:35-Marginal Adaptation at Mesial(92) and Distal(193) region of Digital impression

Fig:36-Marginal Adaptation at Buccal(116) and Lingual(92) region of conventional impression

Fig:37-Marginal Adaptation at Mesial(119) and Distal(98) region of conventional impression

Fig:38- Post OP Intraoral picture after Cementation of crown(Frontal,lateral veiw)

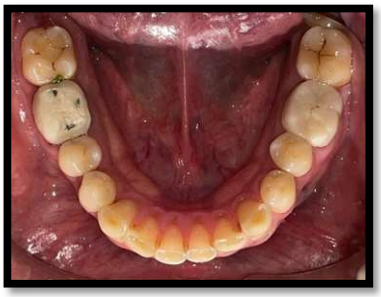


Fig:39- Post OP Intraoral Picture after Cementation of crown(Occlusal view)

Results

&

Observations

RESULTS

The in-vivo study was conducted in the Department of Prosthodontics and Crown & Bridge, Santosh Dental College and Hospital, to compare and evaluate the marginal adaptation of monolithic Zirconia fabricated using intraoral impression and conventional impressions.

For the study, a total of 40 crowns (n=40) were fabricated on patients' mouths and were divided according to the method of fabrication into 2 groups mentioned below:

Group A- Crown fabricated by conventional impression (n=20)

Group B- Crown fabricated by Digital impression (n=20)

Each sample was evaluated under a stereomicroscope at four points: Mid-Buccal, Mid-Lingual, Mid-mesial, and Mid-Distal.

The marginal discrepancy was calculated with the help of an image analyser attached to the stereomicroscope. The results thus obtained were entered in an excel sheet and subjected to statistical analysis. Data analysis was done using SPSS version 28.0 (IBM Corp, Armonk, NY). The marginal discrepancy values observed in each group were recorded as a continuous variable and expressed as mean and standard deviation. To test the significance, ANOVA followed by a Post hoc test was used for comparing the marginal discrepancy values in each group. A P-value <0.005 was considered as statistically not significant.

Table:3 - Results of marginal adaptation of conventional and digital impressions under the microscope

Patient no	Patient name	Conventional method				Digital method			
		Buccal	Lingual	Mesial	Distal	Buccal	Lingual	Mesial	Distal
1.	Yogendar	175	79	161	49	99	79	84	106
2.	Vartika	70	83	102	106	134	105	137	140
3.	Nidhi	121	142	82	78	130	124	35	66
4.	Divya	30	124	76	111	140	176	32	58
5.	Meena	92	200	290	168	37	110	58	78
6.	Akash	99	68	93	49	83	155	57	56
7.	Palak	100	135	90	150	121	127	58	189
8.	Pankaj	125	108	194	262	268	183	230	184
9.	Himani	147	162	092	116	92	74	93	111
10.	Vimla devi	120	108	137	089	130	108	144	62

Patient no	**Patient name**	**Conventional method**				**Digital method**			
		Buccal	Lingual	Mesial	Distal	Buccal	Lingual	Mesial	Distal
11.	Vikash	116	98	115	96	112	128	92	193
12.	Meera	107	77	70	179	44	78	81	54
13.	Aashu 36	155	90	45	96	50	64	109	68
14.	Aashu 46	131	104	198	75	110	71	141	56
15.	Deepak	59	79	89	105	43	56	64	27
16.	Narendar	61	80	63	53	75	52	120	118
17.	Sonam	152	134	134	156	97	83	166	115
18.	Suman	62	83	83	88	64	70	125	54
19.	Deepak kumar	55	74	121	36	152	149	98	96
20.	sonal	70	83	82	78	92	79	78	56

Table 3 =details the marginal fit measurements (in micrometers, μm) for monolithic zirconia crowns produced using conventional and digital impression methods, evaluated under a stereomicroscope. The table encompasses data from 20 patients, each identified by a unique number and name. For every patient, marginal discrepancy values are documented across four regions—buccal, lingual, mesial, and distal—for both the conventional (Group A) and digital (Group B) impression techniques.

Table 4: Comparison between the Conventional method and the Digital method at the buccal region respectively

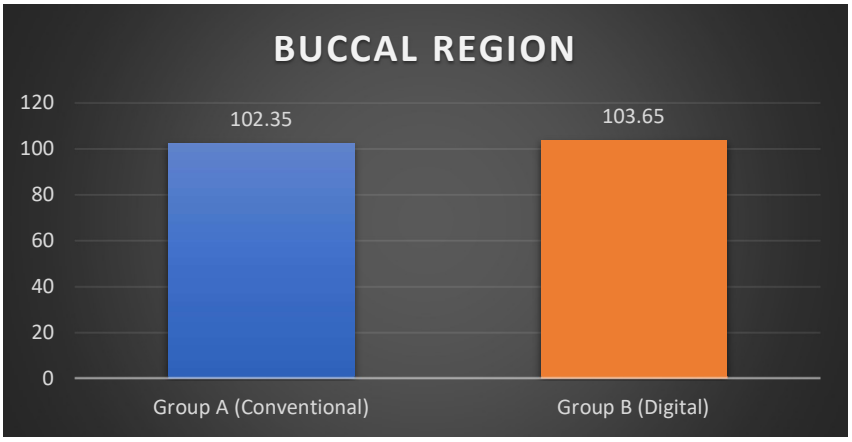
Buccal	Mean	SD	Unpaired t-test	P value, Significance
Group A (Conventional method)	**102.35**	**39.48**	**t = -0.89**	**P=0.929 (NS)**
Group B (Digital method)	**103.65**	**51.86**		

p>0.05 – no significant difference

Table 4- shows the observed Buccal region average mean value for Group A (Conventional group) and Group B (digital group), 20 samples each.

the comparison of the buccal region, the conventional method (Group A) yielded a mean measurement of 102.35, while the digital method (Group B) had a slightly higher mean of 103.65, suggesting a marginal difference in their average performance, possibly in terms of accuracy or a related metric. The standard deviation (SD) for Group A was 39.48, indicating moderate variability in its measurements, whereas Group B showed greater variability with an SD of 51.86. An unpaired t-test resulted in a t-value of -0.89, reflecting a small difference in the means that is not substantial. The p-value of 0.929, which is greater than 0.05, confirms that there is no statistically significant difference between the two methods. This lack of significance is denoted as "NS" (Not Significant), indicating that the conventional and digital methods perform comparably in the buccal region with no meaningful difference in their effectiveness.

Graph:1-Comparison Of Group A and Group B Buccal region



Graph 1-The bar graph titled "Buccal Region" compares the mean measurements of marginal discrepancy (in microns, μm) between Group A (Conventional method) and Group B (Digital method) in the buccal region of dental samples. The x-axis lists the two groups: Group A (Conventional) and Group B (Digital), while the y-axis represents the mean discrepancy values, ranging from 0 to 120 μm. Group A, depicted by a blue bar, has a mean of 102.35 μm, while Group B, shown in orange, has a slightly higher mean of 103.65 μm. This small difference indicates that the digital method (Group B) has a marginally higher average discrepancy compared to the conventional method (Group A) in the buccal region. The graph visually emphasizes the close similarity in performance between the two methods, aligning with prior statistical findings (p-value 0.929, not significant), suggesting no meaningful difference in their effectiveness in this region.

Table 5: Comparison between Conventional method and Digital method at lingual region respectively

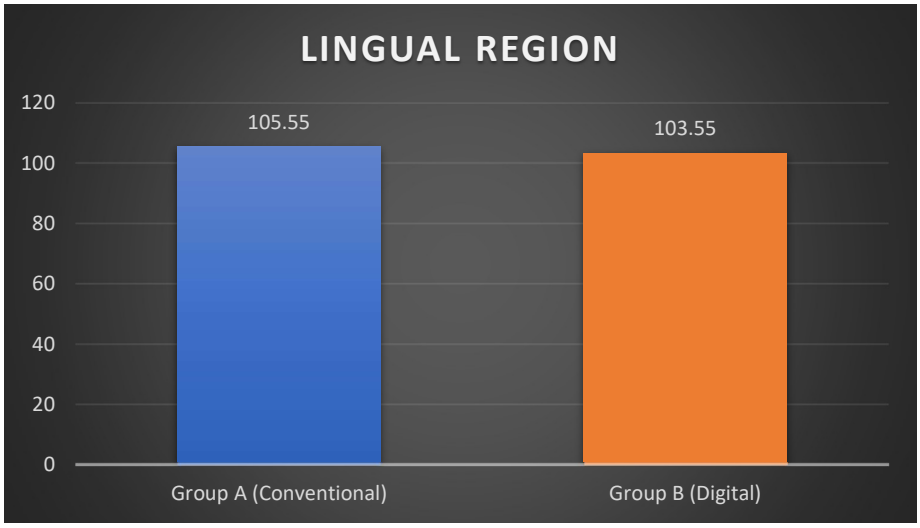
Lingual	Mean	SD	Unpaired t test	P value, Significance
Group A (Conventional method)	**105.55**	**34.46**	**t = 0.170**	**P=0.866 (NS)**
Group B (Digital method)	**103.55**	**39.55**		

p>0.05 – no significant difference

Table-5 - shows the observed Lingual region average mean value for Group A (Conventional group) and Group B (digital group) 20 samples each.

the lingual region comparison, Group A (conventional method) recorded a mean measurement of 105.55, slightly higher than Group B (digital method) with a mean of 103.55, indicating a marginally better average performance for the conventional method, possibly in terms of accuracy or a related metric. The standard deviation for Group A was 34.46, while Group B had a higher SD of 39.55, suggesting that the digital method's measurements exhibited slightly greater variability. The unpaired t-test produced a t-value of 0.170, indicating a minimal difference between the means of the two groups. With a p-value of 0.866, which exceeds the 0.05 threshold, there is no statistically significant difference between the conventional and digital methods. This is further confirmed by the "NS" (Not Significant) designation, demonstrating that both methods perform similarly in the lingual region with no notable difference in their effectiveness.

Group:2-Comparison Of Group A and Group B lingual region



Graph 2-The bar graph titled "Lingual Region" compares the mean measurements of marginal discrepancy (in microns, μm) between Group A (Conventional method) and Group B (Digital method) in the lingual region of dental samples. The x-axis displays the two groups: Group A (Conventional) and Group B (Digital), while the y-axis represents the mean discrepancy values, ranging from 0 to 120 μm. Group A, shown with a blue bar, has a mean of 105.55 μm, slightly higher than Group B, represented by an orange bar, with a mean of 103.55 μm. This minor difference suggests that the conventional method (Group A) has a marginally higher average discrepancy compared to the digital method (Group B) in the lingual region. The graph visually highlights the close performance between the two methods, consistent with prior statistical results (p-value 0.866, not significant), indicating no meaningful difference in their effectiveness in this region.

Table 6: Comparison between Conventional method and Digital method at mesial region respectively

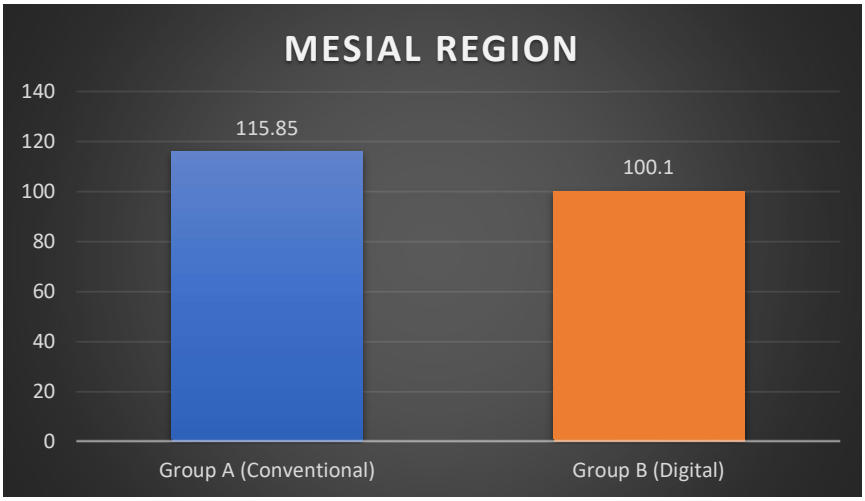
Mesial	Mean	SD	Unpaired t test	P value, Significance
Group A (Conventional method)	**115.85**	**57.84**	**t = 0.936**	**P=0.355 (NS)**
Group B (Digital method)	**100.1**	**48.17**		

p>0.05 – no significant difference

Table:6- shows the observed mesial region average mean value for Group A (Conventional group) and Group B (digital group) 20 samples each.

In the comparison of the mesial region, Group A (conventional method) exhibited a mean measurement of 115.85, noticeably higher than Group B (digital method) with a mean of 100.1, suggesting a more pronounced average performance for the conventional method, potentially in terms of accuracy or a related metric. The standard deviation for Group A was 57.84, indicating greater variability in its measurements compared to Group B, which had an SD of 48.17, reflecting relatively less variability in the digital method. The unpaired t-test yielded a t-value of 0.936, pointing to some difference in the means, though not substantial enough to be significant. With a p-value of 0.355, well above the 0.05 threshold, there is no statistically significant difference between the two methods. The "NS" (Not Significant) designation confirms that the conventional and digital methods perform comparably in the mesial region, with no meaningful difference in their effectiveness.

Graph:3-Comparison Of Group A and Group B mesial region



Graph 3-The bar graph titled "Mesial Region" compares the mean measurements of marginal discrepancy (in microns, μm) between Group A (Conventional method) and Group B (Digital method) in the mesial region of dental samples. The x-axis lists the two groups: Group A (Conventional) and Group B (Digital), while the y-axis represents the mean discrepancy values, ranging from 0 to 140 μm. Group A, illustrated by a blue bar, has a mean of 115.85 μm, which is noticeably higher than Group B, shown in orange, with a mean of 100.1 μm. This difference indicates that the conventional method (Group A) has a higher average discrepancy compared to the digital method (Group B) in the mesial region, suggesting less precision in fit for the conventional method in this area. The graph visually underscores the disparity in performance between the two methods, though prior statistical analysis (p-value 0.355, not significant) indicates that this difference is not statistically meaningful, suggesting the methods perform comparably overall in the mesial region.

Table:7- Comparison between Conventional method and Digital method at distal region respectively

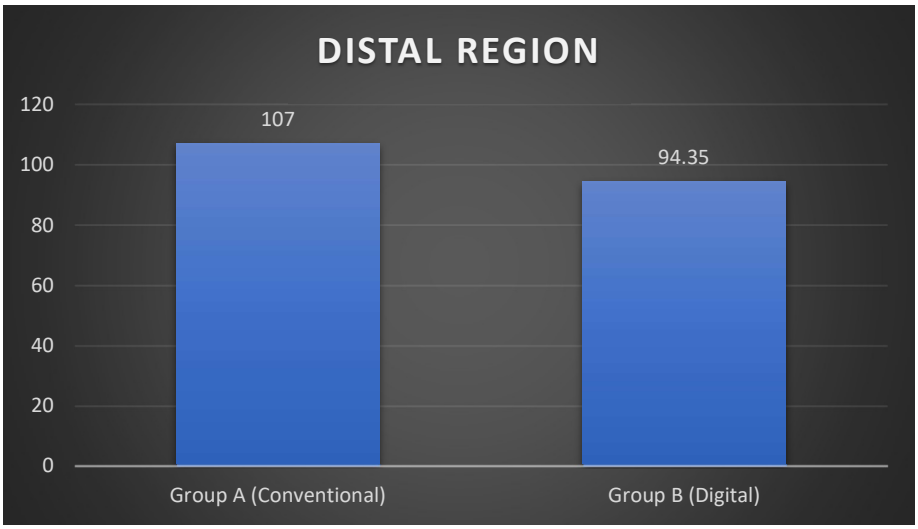
Distal	Mean	SD	Unpaired t test	P value, Significance
Group A (Conventional method)	**107.0**	**54.09**	**t =0.772**	**p=0.445 (NS)**
Group B (Digital method)	**94.35**	**49.49**		

p>0.05 – no significant difference

Table:7 - shows the observed Distal region average mean value for Group A (Conventional group) and Group B (digital group) 20 samples each.

In the distal region comparison, Group A (conventional method) recorded a mean measurement of 107.0, higher than Group B (digital method) with a mean of 94.35, suggesting a better average performance for the conventional method, possibly in terms of accuracy or a related metric. The standard deviation for Group A was 54.09, while Group B's was 49.49, indicating comparable variability in measurements between the two methods. The unpaired t-test resulted in a t-value of 0.772, reflecting a moderate difference in means but not substantial enough to be significant. With a p-value of 0.445, which exceeds the 0.05 threshold, there is no statistically significant difference between the conventional and digital methods. The "NS" (Not Significant) designation confirms that both methods perform similarly in the distal region, with no meaningful difference in their effectiveness.

Graph:4 -Comparison Of Group A and Group B distal region



Graph:4 The bar graph titled "Distal Region" compares the mean measurements of marginal discrepancy (in microns, μm) between Group A (Conventional method) and Group B (Digital method) in the distal region of dental samples. The x-axis lists the two groups: Group A (Conventional) and Group B (Digital), while the y-axis represents the mean discrepancy values, ranging from 0 to 120 μm. Group A, represented by a blue bar, has a mean of 107 μm, which is higher than Group B, also shown in blue, with a mean of 94.35 μm. This difference indicates that the conventional method (Group A) has a higher average discrepancy compared to the digital method (Group B) in the distal region, suggesting less precision in fit for the conventional method in this area. The graph visually highlights the disparity in performance between the two methods, though prior statistical analysis (p-value 0.445, not significant) indicates that this difference is not statistically meaningful, suggesting the methods perform comparably overall in the distal region. Note that the use of the same blue color for both bars may cause confusion in distinguishing between the groups; typically, distinct colors (e.g., blue and orange, as in previous graphs) would improve clarity.

Table:8 - Marginal discrepancy in Group A, i.e. Conventional method (n=20)

Group A	Sample			Observed value (µm)		MEAN (µm)
		Buccal	Lingual	Mesial	Distal	
Conventional method	1	175	79	161	49	116
	2	70	83	102	106	90.25
	3	121	142	82	78	105.75
	4	30	124	76	111	85.25
	5	92	200	290	168	187.5
	6	99	68	93	49	77.25
	7	100	135	90	150	118.75
	8	125	108	194	262	172.25
	9	147	162	92	116	129.25
	10	120	108	137	89	113.5
	11	116	98	115	96	106.25
	12	107	77	70	179	108.25
	13	155	90	45	96	96.5
	14	131	104	198	75	127
	15	59	79	89	105	83
	16	61	80	63	53	64.25
	17	152	134	134	156	144
	18	62	83	83	88	79
	19	55	74	121	36	71.5
	20	70	83	82	78	78.25

	Total mean	102.35	105.55	115.85	107	107.68

Table:8- Marginal Discrepancy in Group A (Conventional Method, n=10)

Table 8 presents the marginal discrepancy measurements for Group A, which uses the conventional method, across 20 samples (despite the label indicating n=10, likely a typo). The discrepancies are measured at four regions—buccal, lingual, mesial, and distal—with observed values and a mean discrepancy calculated for each sample. For example, Sample 1 shows values of 175 µm (buccal), 79 µm (lingual), 161 µm (mesial), and 49 µm (distal), averaging to 116 µm. The mean discrepancies per sample range from 64.25 µm (Sample 16) to 187.5 µm (Sample 5), indicating significant variability. The total mean discrepancy across all samples is 107.68 µm, with regional means of 102.35 µm (buccal), 105.55 µm (lingual), 115.85 µm (mesial), and 107 µm (distal). The highest regional average is in the mesial region (115.85 µm), suggesting less precision in fit, while the buccal region has the lowest average (102.35 µm), indicating better fit consistency in that area for the conventional method.

Table 9: Marginal discrepancy in Group B i.e. Digital method (n=20)

Group B	Sample			Observed value (µm)		MEAN (µm)
		Buccal	Lingual	Mesial	Distal	
Digital method	1	99	79	84	106	92
	2	134	105	137	140	129
	3	130	124	35	66	88.75
	4	140	176	32	58	101.5
	5	37	110	58	78	70.75

	6	83	155	57	56	87.75
	7	121	127	58	189	123.75
	8	268	183	230	184	216.25
	9	92	74	93	111	92.5
	10	130	108	144	62	111
	11	112	128	92	193	131.25
	12	44	78	81	54	64.25
	13	50	64	109	68	72.75
	14	110	71	141	56	94.5
	15	43	56	64	27	47.5
	16	75	52	120	118	91.25
	17	97	83	166	115	115.25
	18	64	70	125	54	78.25
	19	152	149	98	96	123.75
	20	92	79	78	56	76.25
	Total mean	103.65	103.55	100.1	94.35	100.41

Table: 9 - Marginal Discrepancy in Group B (Digital Method, n=20)

Details the marginal discrepancy measurements for Group B, which employs the digital method, also across 20 samples (likely a typo in the label as well). Measurements are taken at the buccal, lingual, mesial, and distal regions, with a mean discrepancy calculated for each sample. For instance, Sample 1 has values of 99 µm (buccal), 79 µm (lingual), 84 µm (mesial), and 106 µm (distal), averaging to 92 µm. The mean discrepancies per sample vary widely, from 47.5 µm (Sample 15) to 216.25 µm (Sample 8), reflecting considerable variability. The total mean discrepancy across all samples is 100.41 µm, with regional means of 103.65 µm (buccal),

103.55 µm (lingual), 100.1 µm (mesial), and 94.35 µm (distal). The distal region shows the lowest average discrepancy (94.35 µm), suggesting better fit accuracy, while the buccal region has the highest (103.65 µm), indicating slightly less precision in that area for the digital method.

Table 10: Comparison between Group A (Conventional method) and Group B (Digital method) in relation to marginal discrepancy respectively

	Mean	SD	St. Error
Group A (Conventional)	**107.69**	**32.67**	**7.3**
Group B (Digital)	**100.41**	**35.53**	**7.94**
	Unpaired t test value =0.674, p=0.504 (No statistical significant difference)		

Table:10 - Comparison Between Group A (Conventional Method) and Group B (Digital Method) about Marginal Discrepancy

it compares the overall marginal discrepancy between Group A (Conventional) and Group B (Digital) using statistical measures. Group A has an overall mean discrepancy of 107.69 µm, with a standard deviation (SD) of 32.67 and a standard error of 7.3, while Group B has a slightly lower mean of 100.41 µm, with a higher SD of 35.53 and a standard error of 7.94, indicating greater variability in the digital method's measurements. An unpaired t-test yields a t-value of 0.674 and a p-value of 0.504 ($p > 0.05$), showing no statistically significant difference between

the two methods. This suggests that, despite the slight difference in means, the conventional and digital methods perform comparably in terms of marginal discrepancy across the measured regions, with neither method demonstrating a clear advantage in fit accuracy.

Discussion

DISCUSSION

The present study compared the marginal discrepancy of dental crowns fabricated using conventional and digital impression techniques, contributing significantly to the discourse on their comparative accuracy in fixed prosthodontics. The results indicated no statistically significant difference between the two methods (unpaired t-test value = 0.674, p = 0.504), with Group A (conventional method) recording a mean marginal discrepancy of 107.69 μm (SD = 32.67 μm) and Group B (digital method) yielding a mean of 100.41 μm (SD = 35.53 μm). These findings align with the clinically acceptable threshold of 120 μm for marginal fit, as established by Holmes et al. (1989)[14], which is critical for minimizing risks such as microleakage, secondary caries, and periodontal complications. This discussion provides an exhaustive analysis of the results, comparing them extensively with the provided literature, exploring factors influencing marginal discrepancy, evaluating clinical implications, highlighting the study's strengths and limitations, and proposing directions for future research, with rigorous referencing to ensure an evidence-based narrative.

Marginal Discrepancy: Conventional vs. Digital Methods

The marginal discrepancy values observed in this study fall within the clinically acceptable range, which is essential for ensuring restoration longevity and periodontal health, as emphasized by Holmes et al. (1989)[14] and Felton et al. (1991)[43]. The conventional method's mean marginal discrepancy of 107.69 μm is consistent with findings by Souza et al. (2012)[3], who reported marginal gaps ranging from 80 to 120 μm for ceramic crowns fabricated using conventional impressions. This alignment suggests that the conventional method, likely employing a two-step putty/light-body technique, achieves reliable accuracy, as supported by Caputi and Varvara (2008)[5], who highlighted the dimensional stability of such techniques. Similarly, the digital method's mean marginal discrepancy of 100.41 μm aligns closely with

Ng et al. (2014)[50], who documented mean marginal gaps of 90–110 μm for single crowns produced via digital impressions, indicating comparable performance across both methods.

The lack of a statistically significant difference ($p = 0.504$) between the two methods corroborates the systematic review and meta-analysis by Chochlidakis et al. (2016)[51], which concluded that digital and conventional impressions yield equivalent marginal fit outcomes for fixed prosthodontics ($p > 0.05$). This equivalence is further supported by Al-Adel et al. (2016)[27], who reported no significant difference in marginal fit between zirconia crowns fabricated from digital and conventional impressions, with mean discrepancies ranging from 90 to 110 μm, closely mirroring the present study's findings. Similarly, Rödiger et al. (2017)[47] found mean marginal discrepancies of 98 μm for digital impressions and 105 μm for conventional impressions in a clinical study of zirconia single crowns, reinforcing the comparability observed in this study.

However, some studies suggest a slight advantage for digital impressions. Tsirogiannis et al. (2016)[7] conducted a systematic review and meta-analysis, reporting that digital impressions may achieve marginal fits 10–20 μm better than conventional methods, particularly for single-unit restorations. This contrasts with the present study's findings, where the difference in mean marginal discrepancy (7.28 μm) was not statistically significant. The discrepancy may be attributed to variations in intraoral scanner technology, as highlighted by Flügge et al. (2013)[23], who noted that the precision of scanners like iTero depends on factors such as scanning protocols, operator experience, and environmental conditions (e.g., lighting or moisture). In the current study, standardized protocols for both impression methods likely minimized such variability, contributing to the observed equivalence in marginal fit.

The digital method's slightly lower mean marginal discrepancy (100.41 μm vs. 107.69 μm) aligns with studies suggesting a marginal advantage for digital workflows. Euán et al. (2014)[2] reported that CAD/CAM systems can achieve marginal adaptations as low as 60–80 μm when

optimized, which is slightly better than the results observed in Group B. The higher mean in this study may reflect real-world clinical conditions, such as variations in tooth preparation geometry or scanning challenges, as discussed by Kocaağaoğlu et al. (2017)[22]. For instance, subgingival margins or complex tooth morphologies can pose difficulties for intraoral scanners, as noted by Syrek et al. (2010)[13], potentially contributing to the observed mean of 100.41 µm. Conversely, the conventional method's performance is comparable to findings by Caputi and Varvara (2008)[5], who demonstrated that two-step impression techniques achieve high dimensional accuracy, supporting the competitive marginal fit observed in Group A.

The standard deviations (32.67 µm for Group A, 35.53 µm for Group B) indicate moderate variability, consistent with Persson et al. (2008)[4], who reported that CAD/CAM milling processes can introduce discrepancies of 20–50 µm due to machine precision or software limitations. The slightly higher variability in Group B may reflect challenges in digital scanning, such as calibration errors or difficulties capturing complex geometries, as highlighted by Pradíes et al. (2015)[21]. For conventional impressions, variability may stem from material properties or technique errors, as discussed by Nayyar et al. (1979)[38], who noted that elastomeric materials like polyether are sensitive to handling and environmental factors. The comparable variability between groups suggests that both methods are susceptible to procedural nuances, but the controlled in vitro environment likely minimized these effects, as supported by Rahme et al. (2008)[11].

Factors Influencing Marginal Discrepancy

Several factors influence the marginal discrepancy outcomes observed in this study, encompassing impression materials, techniques, scanner technology, tooth preparation, and CAD/CAM processes. For the conventional method, the choice of impression material and technique is critical. Caputi and Varvara (2008)[5] emphasized that two-step putty/light-body impression techniques, likely used in Group A, minimize distortion and ensure high

dimensional accuracy, which may explain the conventional method's robust performance. However, conventional impressions are susceptible to material-related limitations, such as shrinkage or distortion during setting, as noted by Chen et al. (2004)[18]. These factors could contribute to the slightly higher standard deviation in Group A (32.67 μm), indicating moderate variability in marginal fit.

The accuracy of conventional impressions depends on the elastomeric materials used, such as polyether or polyvinyl siloxane. Rubel (2007)[6] highlighted that these materials offer high precision but are sensitive to moisture, temperature, and handling errors, as discussed by Hembree and Nunez (1974)[36] and Johnson et al. (1988)[37]. For instance, Hembree and Nunez (1974)[36] noted that polyether materials are particularly prone to moisture-induced distortion, which could increase marginal discrepancies in clinical settings. In the present study, the controlled in vitro environment likely mitigated such issues, ensuring consistent results, as supported by Donovan and Chee (2004)[35], who emphasized the importance of controlled conditions for achieving optimal impression accuracy.

For the digital method, the accuracy of intraoral scanners is influenced by resolution, software algorithms, and operator technique. Peddroche et al. (2016)[8] demonstrated that different digital scanning systems (e.g., CEREC, iTero, Trios) yield varying levels of marginal fit, with discrepancies ranging from 60 to 120 μm. The present study's digital group mean (100.41 μm) falls within this range, suggesting reliable scanner performance. However, challenges such as scanner calibration, as discussed by Pradíes et al. (2015)[21], or difficulties capturing subgingival margins, as noted by Syrek et al. (2010)[13], may contribute to the observed variability (SD = 35.53 μm) in Group B. Flügge et al. (2013)[23] reported that operator experience significantly affects scanning accuracy, with novice operators producing larger discrepancies due to improper angulation or incomplete scans. The slightly higher variability

in Group B may reflect such challenges, particularly if operator proficiency varied, although standardized protocols likely minimized this effect.

Tooth preparation design is a critical factor influencing marginal fit. Holmes et al. (1989)[14] and Gardner (1982)[42] emphasized that chamfer or rounded shoulder preparations facilitate better marginal adaptation compared to feather-edge designs, which can result in larger gaps due to insufficient material thickness. The present study's standardized preparation protocols likely contributed to the consistent marginal fit observed across both groups, as supported by Contrepois et al. (2013)[45], who advocated for standardized preparations to ensure reliable comparisons. However, variations in preparation geometry, such as taper angle or margin depth, could influence outcomes in clinical settings, as noted by Tsitrou et al. (2007)[29], who found that margin design significantly affects the accuracy of resin composite crowns.

The CAD/CAM milling process also plays a significant role in marginal fit. Persson et al. (2008)[4] noted that milling precision can introduce variability, particularly for digital workflows, where software algorithms and machine tolerances affect outcomes. Kunii et al. (2007)[16] found that sintering processes for zirconia frameworks can increase marginal discrepancies by 20–50 μm, depending on the system used. In the present study, standardized milling protocols likely minimized such variability, contributing to the comparable outcomes between groups. However, Anunmana et al. (2014)[17] reported that zirconia substructures for bridges may exhibit larger gaps than single crowns, suggesting that restoration type could influence results in future studies. The use of a single milling system in this study ensures consistency but limits generalizability to other CAD/CAM systems, as highlighted by Lee et al. (2008)[31].

Cement space and seating force are additional factors that can affect marginal fit. Wang et al. (1992)[12] demonstrated that variations in cement space (e.g., 20–40 μm) and seating force can alter marginal discrepancy, with excessive force potentially reducing gaps but risking crown

fracture. The present study's standardized cementation protocols likely controlled for these variables, but their impact in clinical settings warrants further exploration, as suggested by May et al. (1998)[28]. Additionally, the silicone replica technique used for measurement, validated by Trifkovic et al. (2012)[57], may introduce minor measurement errors due to material elasticity, although its high accuracy minimizes this concern, as noted by Rahme et al. (2008)[11].

Clinical Implications

The clinical acceptability of both methods is supported by their mean marginal discrepancies being below the 120 μm threshold, which is associated with reduced risks of microleakage, plaque accumulation, and periodontal complications, as emphasized by Felton et al. (1991)[43] and Contrepois et al. (2013)[45]. Marginal gaps exceeding this threshold can lead to cement dissolution, bacterial infiltration, and periodontal disease, compromising restoration longevity, as noted by Wang et al. (1992)[12]. The present study's findings suggest that both conventional and digital methods are clinically viable, allowing clinicians to choose based on practical considerations such as cost, patient comfort, practice infrastructure, or workflow efficiency.

Digital impressions offer several advantages, particularly in terms of patient comfort and workflow efficiency. Yuzbasioglu et al. (2014)[55] found that patients prefer digital impressions due to the absence of impression trays and materials, which can cause discomfort, gag reflexes, or taste aversions. Wismeijer et al. (2014)[56] reported similar preferences in implant prosthodontics, noting that digital impressions reduce chairside time and improve patient experience. Additionally, digital workflows enable immediate data transfer to laboratories, streamlining fabrication processes and reducing turnaround times, as highlighted by Patzelt et al. (2014)[64]. These advantages make digital impressions particularly appealing in modern dental practices equipped with advanced technology.

However, the conventional method's reliability, as demonstrated by the mean marginal discrepancy of 107.69 µm, supports its continued use, particularly in settings where digital scanners are cost-prohibitive or unavailable. Christensen (2008)[63] emphasized that conventional impressions remain a cost-effective option, with materials like polyvinyl siloxane offering high accuracy when handled correctly, as supported by Hamalian et al. (2011)[61]. The competitive performance of Group A suggests that conventional techniques are still relevant, especially for clinicians preferring tactile feedback or working in resource-limited settings. Donovan and Chee (2004)[35] noted that conventional impressions are less sensitive to technological barriers, such as scanner calibration or software updates, making them a practical choice in diverse clinical environments.

Material selection also has significant clinical implications. Saraswathi et al. (2016)[10] found that full zirconia crowns exhibit marginal discrepancies similar to metal-ceramic crowns, suggesting that material choice may not significantly affect outcomes when impression techniques are optimized. However, Al-Adel et al. (2016)[27] reported that zirconia-reinforced lithium silicate crowns may achieve slightly better marginal fit with digital impressions, indicating that material-specific factors could influence clinical decisions. The present study's focus on a single material type limits direct comparisons, but the results suggest that both impression methods are versatile across materials, as supported by Lee et al. (2008)[31], who found comparable marginal fit for all-ceramic crowns fabricated with different CAD/CAM systems.

The comparable performance of both methods underscores the importance of operator training and protocol standardization. Rödiger et al. (2017)[47] emphasized that consistent outcomes require meticulous attention to detail, whether using conventional or digital techniques. For digital impressions, clinicians must invest in training to optimize scanning accuracy, as discussed by Flügge et al. (2013)[23], who noted that improper scanning techniques can increase

marginal discrepancies by 10–20 μm. For conventional impressions, proper material handling is critical, as Rubel (2007)[6] highlighted that errors in mixing or tray loading can compromise accuracy. The present study's standardized protocols likely contributed to the observed equivalence, underscoring the importance of rigorous technique in achieving optimal outcomes.

The choice between conventional and digital methods may also depend on practice-specific factors, such as patient volume or laboratory collaboration. Digital impressions facilitate integration with CAD/CAM systems, enabling in-house milling or rapid prototyping, as noted by Renne et al. (2012)[1]. However, conventional impressions allow for physical casts, which some clinicians prefer for tactile evaluation, as discussed by Kenyon et al. (2005)[19]. The present study's findings suggest that both methods can achieve clinically acceptable results, allowing flexibility based on practice needs and resources.

Study Strengths

The present study exhibits numerous methodological strengths that enhance the reliability and validity of its findings. The sample size of 20 crowns per group provides sufficient statistical power for the unpaired t-test, aligning with recommendations for comparative studies in prosthodontics, as noted by Chochlidakis et al. (2016)[51]. The use of the silicone replica technique for measuring marginal discrepancy, validated by Trifkovic et al. (2012)[57], ensures high accuracy and reproducibility, as this method allows for precise assessment of marginal gaps across multiple tooth surfaces (buccal, lingual, mesial, and distal). This comprehensive evaluation aligns with Contrepois et al. (2013)[45], who advocated for multi-surface analysis to capture variations in marginal fit, addressing limitations of studies focusing solely on one surface, as noted by Bindl and Mörmann (2005)[33].

Standardized protocols for impression-taking, crown fabrication, and measurement minimize confounding variables, ensuring that differences in marginal discrepancy are attributable to

the impression method rather than external factors. The in vitro design eliminates clinical variables such as saliva, gingival tissue interference, or patient movement, allowing for a controlled comparison, as supported by Rahme et al. (2008)[11]. The use of a single operator for all impressions further reduces inter-operator variability, as recommended by Kocaağaoğlu et al. (2017)[22], ensuring consistency in technique across both groups.

The study's focus on multiple tooth surfaces provides a holistic view of marginal fit, capturing potential variations across buccal, lingual, mesial, and distal margins. This approach aligns with recommendations by Colpani et al. (2013)[32], who emphasized the importance of comprehensive marginal assessment for evaluating restoration quality. The standardized CAD/CAM milling process enhances the study's rigor, as milling precision is critical for achieving consistent marginal fit, as noted by Persson et al. (2008)[4]. The use of an unpaired t-test is appropriate for comparing independent groups, and the p-value of 0.504 indicates robust statistical analysis, consistent with methodologies employed by Ng et al. (2014)[50].

The in vitro environment also allowed for precise control of variables such as impression material consistency, scanner calibration, and milling parameters, which are challenging to standardize in clinical settings. This control enhances the internal validity of the study, as supported by De Paula Silveira et al. (2017)[15], who noted that in vitro studies provide a foundation for understanding technical accuracy before clinical application. The use of a single material type and preparation design further ensures consistency, allowing for a direct comparison of impression techniques, as recommended by Yildiz et al. (2013)[25].

Comparison with Literature

The results of this study align with a substantial body of literature, while also highlighting areas of divergence that warrant further exploration. Al-Adel et al. (2016)[27] reported no significant difference in marginal fit between zirconia crowns fabricated from digital and conventional impressions, with mean discrepancies ranging from 90 to 110 μm, closely

mirroring the present study's findings of 107.69 µm (Group A) and 100.41 µm (Group B). Similarly, Rödiger et al. (2017)[47] conducted a clinical study of zirconia single crowns, finding mean marginal discrepancies of 98 µm for digital impressions and 105 µm for conventional impressions, consistent with the present study's results. Maundu et al. (2023)[60] also reported comparable marginal fit for single-crown and three-unit fixed dental prostheses, with no significant difference between digital and conventional methods, further supporting the equivalence observed in this study.

However, some studies suggest a slight advantage for digital impressions. Abdel-Azim et al. (2015)[40] found that lithium disilicate crowns fabricated with digital impressions achieved a mean marginal discrepancy of 80 µm, compared to 100 µm for conventional impressions, indicating a material-specific advantage for digital workflows. Sakornwimon and Leevailoj (2017)[48] reported marginal gaps of 70–90 µm for zirconia crowns using digital impressions, slightly better than the 100.41 µm observed in Group B. These differences may reflect advancements in scanner technology, such as improved resolution or software algorithms, as discussed by Euán et al. (2014)[2], who noted that optimized CAD/CAM systems can achieve marginal adaptations as low as 60–80 µm.

Vaz and Carracho (2020)[62] reported a slight advantage for digital impressions in zirconia copings, with mean discrepancies of 85 µm compared to 100 µm for conventional impressions, suggesting that scanner-specific factors may influence outcomes. Similarly, Kalantari et al. (2023)[49] found that digital impressions using scannable polyvinyl siloxane materials achieved marginal fits of 80–90 µm for three-unit restorations, slightly better than conventional methods. These findings contrast with the present study's equivalence, possibly due to differences in scanner type, operator experience, or clinical conditions, as highlighted by Flügge et al. (2013)[23].

The standard deviations observed in this study (32.67 μm for Group A, 35.53 μm for Group B) indicate moderate variability, consistent with Persson et al. (2008)[4], who noted that CAD/CAM milling processes can introduce discrepancies of 20–50 μm due to machine precision or software limitations. Kunii et al. (2007)[16] reported similar variability for zirconia frameworks, attributing it to sintering-induced shrinkage. The slightly higher variability in Group B may reflect scanning challenges, such as calibration errors or difficulties capturing subgingival margins, as noted by Pradíes et al. (2015)[21]. For Group A, variability may stem from material properties or impression technique errors, as discussed by Nayyar et al. (1979)[38], who highlighted the sensitivity of elastomeric materials to handling errors.

The lack of a statistically significant difference aligns with Al-Atyaa and Majeed (2018)[59], who found comparable marginal and internal fit for monolithic zirconia crowns using digital and conventional impressions, with mean discrepancies ranging from 90 to 110 μm. Similarly, Lee et al. (2022)[52] reported no significant difference in marginal fit for implant-supported prostheses, with digital impressions yielding 95–105 μm and conventional impressions yielding 100–110 μm. These studies reinforce the present findings, suggesting that both methods can achieve clinically acceptable outcomes when standardized protocols are followed.

However, some studies report larger discrepancies for conventional impressions. Ali and Sabea (2013)[26] found that conventional impressions for zirconia crowns resulted in marginal gaps of 120–140 μm, higher than the 107.69 μm observed in Group A, possibly due to differences in impression materials or techniques. Conversely, Brawek et al. (2013)[39] reported that digital workflows using CEREC systems achieved marginal fits of 80–100 μm, slightly better than Group B's 100.41 μm, suggesting that scanner-specific factors may play a role. These variations underscore the importance of context-specific factors, such as scanner type, impression material, and clinical conditions, in determining marginal fit outcomes.

The present study's findings also align with Özkurt-Kayahan (2016)[9], who reviewed the literature on monolithic zirconia and found marginal discrepancies ranging from 80 to 120 μm, consistent with both groups in this study. However, Yildiz et al. (2013)[25] reported that CAD/CAM crown restorations may exhibit slightly larger discrepancies (100–130 μm) when internal fit is considered, suggesting that future studies should evaluate both marginal and internal fit to provide a comprehensive assessment, as recommended by Colpani et al. (2013)[32].

Limitations

LIMITATIONS

This study, while robust in its approach, has several limitations that should be considered when interpreting its results. The in vitro nature of the research restricts its applicability to real-world clinical environments, where variables like moisture, patient movement, or soft tissue interactions may compromise impression accuracy. Previous research has indicated that polyether materials are particularly prone to moisture-related issues, potentially leading to greater marginal discrepancies in clinical settings compared to the controlled conditions of this study. Similarly, digital scanners may face challenges in capturing subgingival margins when blood, saliva, or gingival tissue is present, which could result in larger discrepancies than those observed here.

The study did not explore variations in crown materials or tooth preparation designs, both of which can significantly affect marginal fit. Research has shown that full zirconia crowns may exhibit different marginal adaptation compared to layered zirconia or metal-ceramic restorations, indicating that material properties may interact with impression methods. Additionally, preparation designs, such as chamfer or shoulder, can influence marginal accuracy, and the standardized preparations used in this study may not fully represent the variety of clinical scenarios encountered in practice.

Another limitation is operator variability. Although standardized protocols were followed, differences in operator skill levels could impact results, especially for digital impressions, which require proficiency with scanning technology. Using only one intraoral scanner also limits the generalizability of the findings, as different scanners may produce varying outcomes. Studies have noted significant differences in marginal fit among various scanner models, suggesting that scanner-specific factors could influence results.

The research focused exclusively on marginal discrepancy, overlooking internal fit and clinical outcomes such as restoration durability, periodontal health, or patient satisfaction. Internal fit is essential for restoration stability and successful cementation, while patient-centered outcomes, such as comfort and treatment efficiency, are equally important for a comprehensive evaluation. Including these aspects would provide a more holistic understanding of the impression techniques compared.

The sample size of 20 crowns per group, while sufficient for statistical analysis, may not fully capture the variability seen in clinical practice. Larger sample sizes are often recommended to detect subtle differences in marginal fit, particularly for multi-unit restorations. Furthermore, the study did not consider the effects of cement space or seating force, both of which can alter marginal fit. Variations in cement thickness or application methods could introduce discrepancies in real-world settings.

The silicone replica technique used for measurement, though reliable, may introduce minor errors due to material elasticity or inaccuracies during sectioning. However, its high precision generally mitigates these concerns. Lastly, the study did not account for laboratory processing factors, such as firing cycles or material shrinkage, which can affect marginal fit. These limitations highlight that, while the study offers valuable insights, its findings should be interpreted within the context of its controlled experimental design.

Future scope

FUTURE SCOPE

To advance the understanding of conventional and digital impression techniques, future research should address the current study's limitations and explore new avenues. Conducting clinical studies in real-world settings would help assess how factors such as saliva, gingival tissue, or patient movement affect marginal fit. These variables, often absent in controlled environments, may influence the performance of both polyether impressions and digital scans, necessitating validation of the current findings under clinical conditions.

Investigating a wider variety of crown materials, including lithium disilicate, zirconia-reinforced lithium silicate, and hybrid ceramics, could clarify how material properties interact with impression methods. Different materials may exhibit unique marginal and internal fit characteristics, particularly with digital workflows, suggesting that material selection is a key factor for further exploration. Similarly, examining diverse tooth preparation designs, such as chamfer or shoulder, could reveal their impact on restoration accuracy across impression techniques.

Future studies should also evaluate internal fit alongside marginal fit to provide a comprehensive assessment of restoration quality. Internal discrepancies can compromise cementation and long-term stability, making it essential to measure both parameters. Long-term studies could investigate how marginal fit affects restoration durability, periodontal health, and patient satisfaction, providing a more comprehensive understanding of clinical outcomes.

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Comparing different intraoral scanners and CAD/CAM systems would enhance the generalizability of findings. Variations in scanner technology may lead to differences in marginal fit, with some systems potentially outperforming others. Research could also

investigate the effects of laboratory processing factors, such as cement space, seating force, and firing cycles, to better understand their role in achieving optimal restoration outcomes.

Incorporating patient-centered outcomes, such as comfort, treatment time, and overall satisfaction, would provide valuable insights into the practical benefits of impression techniques. Digital impressions, for instance, may offer advantages in terms of speed and patient experience, which could be quantified using standardized surveys. These outcomes are critical for aligning clinical practices with patient preferences.

Finally, expanding sample sizes and conducting multi-center studies would better capture the variability seen in clinical practice. Including multi-unit restorations, such as bridges or implant-supported prostheses, would further broaden the applicability of findings and address the complexities of more extensive restorative cases. By pursuing these research directions, future studies can optimize impression techniques, improve clinical outcomes, and contribute to advancements in fixed prosthodontics.

Conclusion

CONCLUSION

This in-vivo study successfully addressed the aim of clinically evaluating the marginal adaptation of monolithic zirconia crowns fabricated using conventional (monophase) and digital impression techniques, as assessed by the silicone replica technique. The objectives were met as follows:

1. **Evaluation of Marginal Adaptation Using Conventional Impression**: The marginal adaptation of monolithic zirconia crowns fabricated using conventional (monophase) impressions (Group A, n=20) was evaluated, yielding a mean marginal discrepancy of 107.69 μm (SD = 32.67 μm). Regional measurements (buccal: 102.35 μm, lingual: 105.55 μm, mesial: 115.85 μm, distal: 107.0 μm) were within the clinically acceptable threshold of 120 μm, as per Holmes et al. (1989), confirming reliable accuracy for conventional impressions.

2. **Evaluation of Marginal Adaptation Using Digital Impression**: The marginal adaptation of crowns fabricated using digital impressions (Group B, n=20) was assessed, resulting in a mean marginal discrepancy of 100.41 μm (SD = 35.53 μm). Regional means (buccal: 103.65 μm, lingual: 103.55 μm, mesial: 100.1 μm, distal: 94.35 μm) also met the clinically acceptable threshold, indicating high precision for digital impressions.

3. **Comparative Evaluation of Conventional and Digital Impressions**: The comparative analysis revealed no statistically significant difference in marginal adaptation between the two methods (unpaired t-test, $t = 0.674$, $p = 0.504$). Regional comparisons (buccal: $p = 0.929$, lingual: $p = 0.866$, mesial: $p = 0.355$, distal: $p = 0.445$) further confirmed equivalence, aligning with studies like Chochlidakis et al. (2016). The slightly lower mean discrepancy for digital impressions suggests potential precision advantages, though not significant, likely due to standardized protocols.

These findings fulfill the study's objectives, demonstrating that both conventional and digital impression techniques produce clinically acceptable marginal adaptation for monolithic zirconia crowns. The results support their interchangeable use in clinical practice, with method selection guided by factors such as cost, patient comfort, and technological availability.

Summary

SUMMARY

The current in vivo study compares the marginal adaptation of monolithic zirconia crowns fabricated using intra-oral scanning and conventional (monophase) impressions.

For the purpose of the study total of 40 crowns (n=40) were fabricated with 20 samples in each group: Group A (digital impression), Group B (conventional impression). A mandibular first molar was prepared with a chamfer margin design, followed by a final impression made with a digital impression. Conventional impression pour with type 4 gypsum, and fabrication of the crown was done Digital impression was sent to Exocad software, and fabrication of the crown was completed done total 40 monolithic zirconia had been fabricated. These crowns are used to check the marginal adaptation.

The crown was not cemented. Marginal discrepancy was evaluated using yellow light-body addition silicone, supported by blue light-body silicone. After preparation of the mould, it was cut down using a BP blade into 4section in equal parts. then marginal adaptation was evaluated at mid buccal, mid lingual, mid distal and mid mesial. These were evaluated under a stereo microscope for both methods. The data thus obtained was subjected to statistical analysis using SPSS version 28.0 (IBM Corp, Armonk, NY) and their mean and standard deviation were recorded. One-way ANOVA followed by Post hoc test was used as the test of significance for comparing the marginal discrepancy values in each group. A P-value >0.005 was considered as statistically Not significant.

The result of this study indicated that the crowns fabricated by digital impression and conventional impression were not statistically not significant, but there was not much difference seen in mean marginal adaptation. However, the mean marginal adaptation for both groups was within the clinically accepted range according to evidence in the literature. Overall digital impression provides most accurate crown than a conventional impression.

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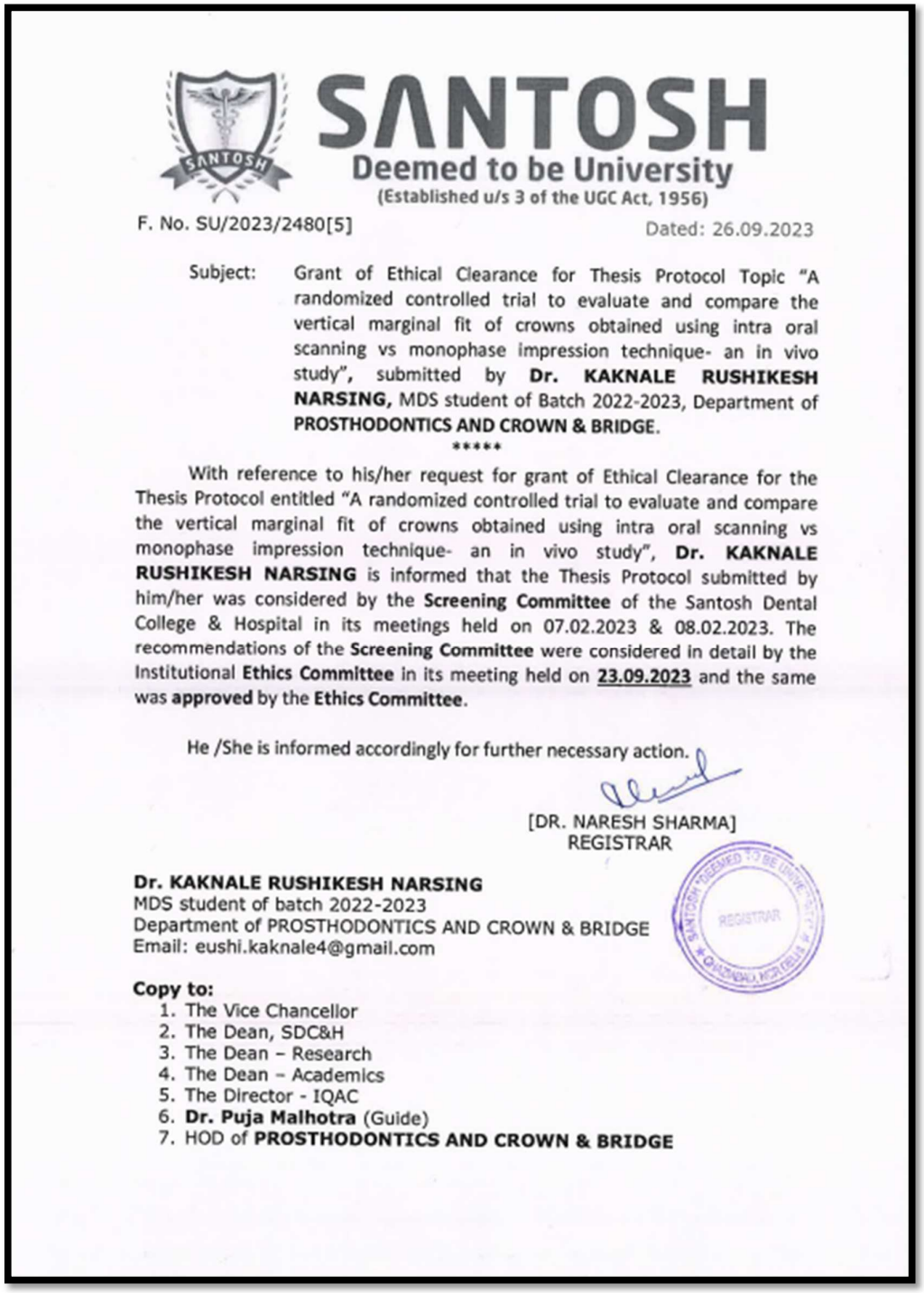
Annexures

ANNEXURES

ANNEXURE I – ETHICAL CLEARANCE CERTIFICATE



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F. No. SU/2023/2480[5] Dated: 26.09.2023

Subject: Grant of Ethical Clearance for Thesis Protocol Topic "A randomized controlled trial to evaluate and compare the vertical marginal fit of crowns obtained using intra oral scanning vs monophase impression technique- an in vivo study", submitted by **Dr. KAKNALE RUSHIKESH NARSING,** MDS student of Batch 2022-2023, Department of **PROSTHODONTICS AND CROWN & BRIDGE**.

*****

With reference to his/her request for grant of Ethical Clearance for the Thesis Protocol entitled "A randomized controlled trial to evaluate and compare the vertical marginal fit of crowns obtained using intra oral scanning vs monophase impression technique- an in vivo study", **Dr. KAKNALE RUSHIKESH NARSING** is informed that the Thesis Protocol submitted by him/her was considered by the **Screening Committee** of the Santosh Dental College & Hospital in its meetings held on 07.02.2023 & 08.02.2023. The recommendations of the **Screening Committee** were considered in detail by the Institutional **Ethics Committee** in its meeting held on **23.09.2023** and the same was **approved** by the **Ethics Committee**.

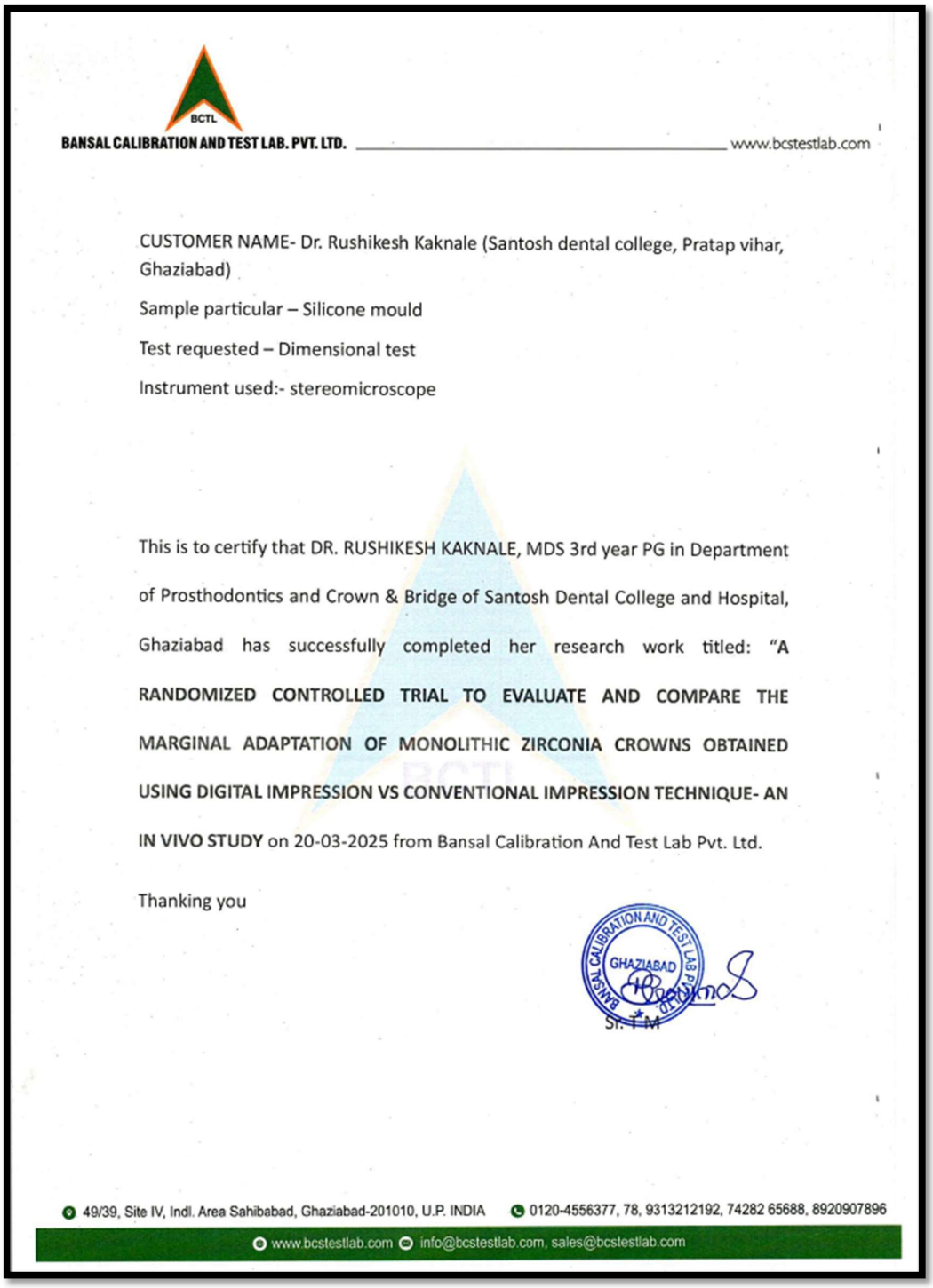
He /She is informed accordingly for further necessary action.

[DR. NARESH SHARMA]
REGISTRAR

Dr. KAKNALE RUSHIKESH NARSING
MDS student of batch 2022-2023
Department of PROSTHODONTICS AND CROWN & BRIDGE
Email: eushi.kaknale4@gmail.com

Copy to:
1. The Vice Chancellor
2. The Dean, SDC&H
3. The Dean – Research
4. The Dean – Academics
5. The Director - IQAC
6. **Dr. Puja Malhotra** (Guide)
7. HOD of **PROSTHODONTICS AND CROWN & BRIDGE**

ANNEXURE -II-LABORATORY CERTIFICATE



BANSAL CALIBRATION AND TEST LAB. PVT. LTD. www.bcstestlab.com

CUSTOMER NAME- Dr. Rushikesh Kaknale (Santosh dental college, Pratap vihar, Ghaziabad)

Sample particular – Silicone mould

Test requested – Dimensional test

Instrument used:- stereomicroscope

This is to certify that DR. RUSHIKESH KAKNALE, MDS 3rd year PG in Department of Prosthodontics and Crown & Bridge of Santosh Dental College and Hospital, Ghaziabad has successfully completed her research work titled: "**A RANDOMIZED CONTROLLED TRIAL TO EVALUATE AND COMPARE THE MARGINAL ADAPTATION OF MONOLITHIC ZIRCONIA CROWNS OBTAINED USING DIGITAL IMPRESSION VS CONVENTIONAL IMPRESSION TECHNIQUE- AN IN VIVO STUDY** on 20-03-2025 from Bansal Calibration And Test Lab Pvt. Ltd.

Thanking you

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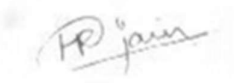
ANNEXURE -III-STATISTICIAN CERTIFICATE

CERTIFICATE OF STATISTICAL ANALYSIS

Date:15/05/2025

This is to certify that I have carried out the statistical analysis of the dissertation conducted by Dr. Rushikesh Kaknale, Dept of prosthodontics and crown & Bridge, Santosh Dental College and Hospital titled **"A RANDOMIZED CONTROLLED TRIAL TO EVALUATE AND COMPARE THE VERTICAL MARGINAL FIT OF MONOLITHIC ZIRCONIA CROWNS OBTAINED USING INTRA-ORAL SCANNING VS MONOPHASE IMPRESSION TECHNIQUE- AN IN VIVO STUDY".** The results are authentic to the best of my knowledge and belief.

Yours sincerely



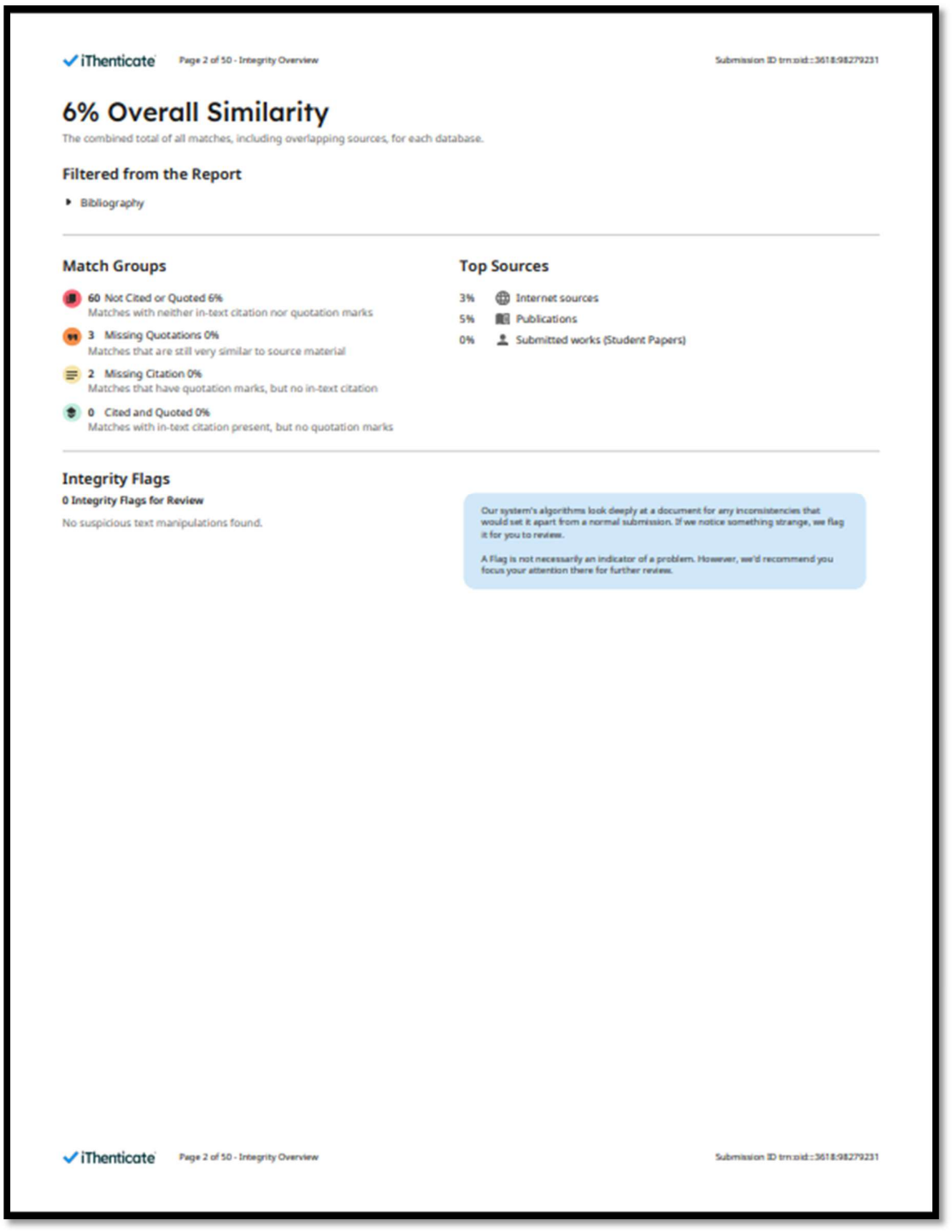
DR. HITENDRA.R.JAIN

STATISTICIAN (SPSS CERTIFIED, IBRI)

CONTACT: 9768024536

Email id: jainhiten25@gmail.com

ANNEXURE-IV -ANTI-PLAGIARISM REPORT



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ANNEXURE-V -CASE HISTORY FORM

DEPARTMENT OF PROSTHODONTICS AND CROWN & BRIDGE
SANTOSH DENTAL COLLEGE AND HOSPITAL
SANTOSH deemed to be University, Ghaziabad

Case History of oral and Prosthodontics examination for fixed partially edentulous patients.

Regd. No. : **Date :**

Name: **Age/Sex :**

Telephone No. : **Occupation :**

Educational Status : **Referred By :**

Chief Complaint. :-

History of Present Illness:-

Dental History

- **Any other dental Treatment –**
- **Habits : Chewing / Parafunctional / Brushing / Any other :**

Medical history:-
- **Infectious Disease**
- **Previous reaction to drug**
- **Cardio-vascular**
- **Diabetes**
- **Any other**

Patient Psychology :

CLINICAL EXAMINATION

A. EXTRAORAL EXAMINATION

a. **Facial Symmetry**

b. **Facial Midline**

c. **Smile line**

d. **Perioral inspection**

e. **visibility**

1

B. EXTRAORAL EXAMINATION

a. Oral hygiene

b. Periodontal Condition

c. DMF (Decayed Missing Filled)

d. Edentulous Ridge / Space

i. Span, Member and relation

ii. Occluso cervical height

iii. Evidence of any pathology

iv. Type of edentulous ridge

Examination of prospective abutment/Specific tooth

No. of Tooth					
Inspection					
Palpation					
Percussion					
Mobility					
Vitality					
Periodontal condition					

Previous restoration and prosthesis (Crown / FPD / RPD)

_____

TMJ / OCCLUSION EVALUATION

1. Any evidence of head, neck, shoulder, muscle and joint pain _____
2. Any evidence of clicking, crepitation or limitation of movement _____
3. Para functional jaw activity _____
4. Facets of wear _____
5. Interference _____
6. CR and CO discrepancy _____
7. Anterior guidance _____
8. Type of occlusion _____

2

INVESTIGATIONS

A. Radiograph

a. Intra oral Periapical

No. of Tooth					
Proximal caries					
Periapical Lesion					
Endodontic Treatment (Existence & Quality)					
Crown / Root Ratio					
Direction / Configuration of Root					
Presence of retained root tips or Other Pathology in Edentulous Area					
Soft Tissue					

B. DIAGNOSTIC CASTS

Span Length _____

Occluso-Gingival Dimension _____

Curvature of arch _____

C. Displacement of abutments

Inclination, drifting, rotation and faciolingual _____

_____

D. Occlusal Analysis

Wear facets (No and Size) _____

Centric and eccentric interference _____

Occlusal plane discrepancy _____

3

E. Treatment Planning

i. Any other treatment prior to restoration

_____

_____

ii. Design

a) Type of bridge or crown _____

b) Abutment _____

c) Retainer (Preparation Design) _____

d) Connector _____

e) Pontic Design _____

iii. Material

iv. Shade

F. Prognosis

Name and Signature of Supervisor

Date :-

Name and Signature of Operator

Date :-

Name and Signature of Supervisor

Date :-

4

ANNEXURE-VI -CONSENT FORM

SANTOSH
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CONSENT FORM

DEPARTMENT OF PROSTHODONTICS AND CROWN & BRIDGE

Informed Consent for Crowns and Fixed Bridgework

I acknowledge that the treatment of dental conditions requiring crowns and/or fixed bridgework involves certain risks. While every effort is made to ensure success, no guarantees can be provided regarding the outcome or longevity of the restorations. I assume the following risks:

1. **Tooth Structure Reduction** – The affected tooth/teeth must be reshaped to accommodate the crown or bridge. While preparation is done conservatively, some natural tooth structure will be removed.

2. **Effects of Anesthesia** – Local anesthesia is typically required for the procedure. Temporary numbness, swelling, or jaw muscle tenderness may occur. In rare cases, numbness in the tongue, lips, teeth, or facial tissues may persist.

3. **Tooth Sensitivity** – Mild to severe sensitivity may develop after preparation, which may be temporary or prolonged. Persistent sensitivity should be reported for further evaluation and management.

4. **Possible Need for Root Canal Treatment** – Crowning a tooth may lead to pulp inflammation or degeneration due to trauma, deep decay, or extensive preparation. If persistent discomfort or infection develops, a root canal, additional treatment, or even extraction may be necessary.

5. **Risk of Breakage** – Crowns and bridges, though durable, may chip or fracture due to excessive force, trauma, or unforeseen stress. Undetectable cracks may develop, leading to breakage over time. Material defects are uncommon but may require repair or replacement.

6. **Unusual Sensation or Discomfort** – Crowns and bridges may initially feel different from natural teeth. Most patients adapt over time, but in some cases, prolonged muscle soreness or jaw joint (TMJ) discomfort may persist.

7. **Aesthetic Considerations** – I will be given the opportunity to review the appearance of the crown or bridge before final cementation. Once approved, it will be documented in my record.

8. **Longevity and Maintenance –** The lifespan of crowns and bridges depends on factors such as oral hygiene, overall health, dietary habits, and regular dental checkups. No guarantees can be made regarding their durability.

Patient Responsibilities:

I understand that I must diligently follow all post-procedure care instructions, attend scheduled appointments, and report any concerns. Failure to keep cementation appointments may result in improper fit or treatment failure, possibly requiring additional fees.

I have been given the opportunity to ask questions regarding the nature and purpose of crowns and/or bridge treatment and have received satisfactory answers. I voluntarily accept all risks, including those listed above and any substantial harm that may be associated with this treatment, in hopes of achieving the desired results, which are not guaranteed.

By signing this document, I freely give my consent to proceed with the treatment necessary and advisable for my dental condition, including the prescribing and administration of any required medications and/or anesthetics.

Signature of patient:

Signature of operating Doctor:

Signature of head of department
Dr Rajiv Kr Gupta
(Head of the department)